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STEAM GENERATION
POWER GENERATION
WATER POWER
OIL & GAS ENGINES
HEATING & VENTILATION
REFRIGERATION
PUMPS & COMPRESSORS
STEAM SERVICES
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POWER MISCELLANY

Volume 79 Number 12

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DECEMBER, 1935

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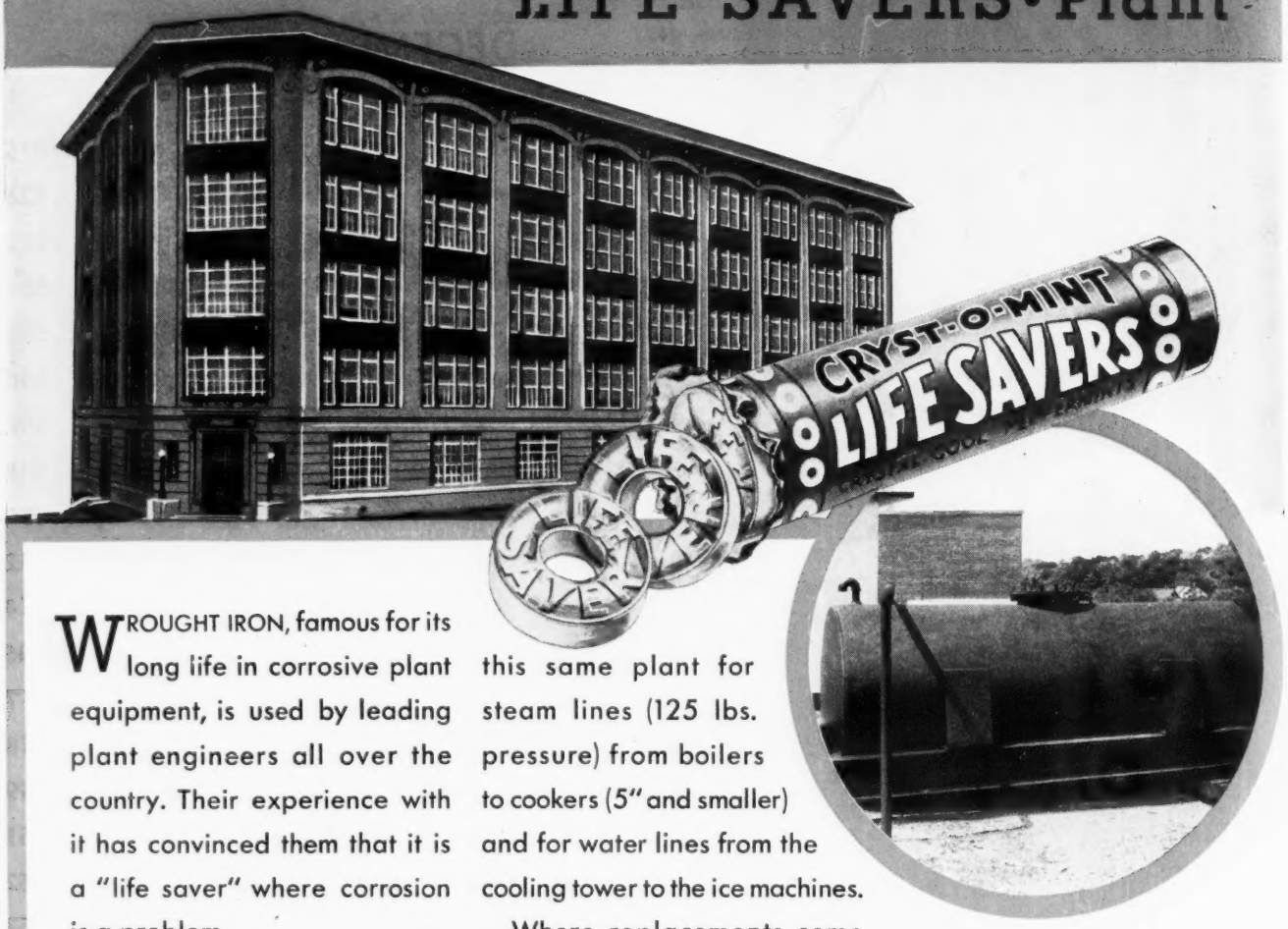

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POWER

A McGraw-Hill Publication—Established 1884
PHILIP W. SWAIN, *Editor*

CHEAPER BETTER STEAM

• POWER here presents still another of its special sections—twenty pages of concise information on boiler design and construction from the user angle.

This fits logically between the 20-page furnace-and-refractory section in September and that on firing planned for next year. Still other special sections in 1936 will round out the picture of steam generation. The aim in all is to get down to brass tacks for the busy reader who has no time to waste, but must have the facts that concern his job.

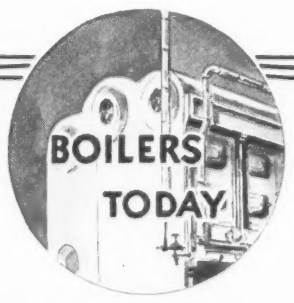
This boiler section, like the others of 1935 (Piping, Maintenance, Diesels, Refractories), and like the five more planned for 1936, is not a compilation of textbook information. It is based directly on field surveys and on many recent conferences with top-notch practical men in the field of boiler design and construction. To these POWER expresses sincere appreciation of enthusiastic cooperation.

Few engineers have operated more than three or four of the many existing types of boilers. They can learn of the others only through inspection trips, conferences and reading. This applies particularly to the many important boiler developments of the last five years, some revolutionary in character. Therefore, we present here a parade of typical boiler types and parts to show you what you may not have seen before.

Subjects summarized in this section include: Boiler types, the designer's problem, joints, drums, headers, dry pipes, steam washers, superheaters, water walls, and baffles. A condensed table on page 633 classifies the power boilers produced by nearly forty manufacturers. This with the bibliography on page 632 should be a real convenience to the user.

Intensive study of power boilers in recent weeks has impressed the editors with the achievements of progressive manufacturers in this field of numberless knotty problems. Through endless balancing of convection, radiation, circulation, gas flow, steam release, superheat, metal characteristics, welding and fabricating procedure, they have found their way to better boilers—boilers that deliver more steam per pound of coal and per pound of metal, more steam per user dollar and per hour of operating trouble. Yet perfection has not been reached; potential progress stretches on into the future.

Today the user who desires the most for his money may have it by intelligent cooperation with the designer, by specifying *results* rather than *means*. He will say, in effect, "I need so much steam at such and such temperature. Here is my load curve. These are my local limitations as to fuel, space, labor, water and so forth. You are the doctor. Design for me the unit that will deliver this steam at the lowest over-all cost and with the degree of dependability justified by the nature of the service."



26 TYPICAL AMERICAN BOILERS

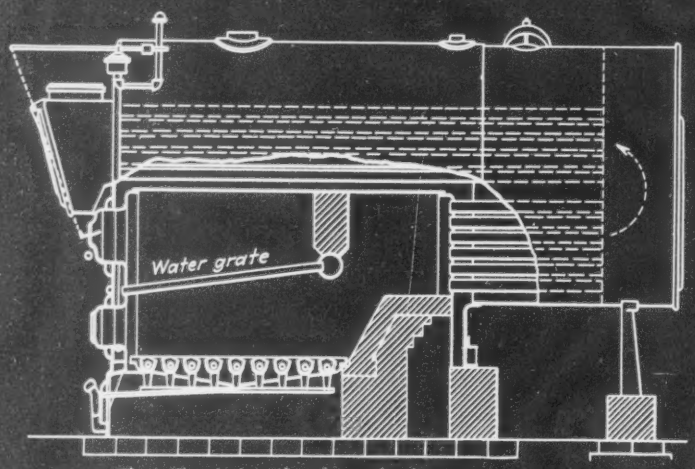


Fig.1-Fire-tube with down-draft grate

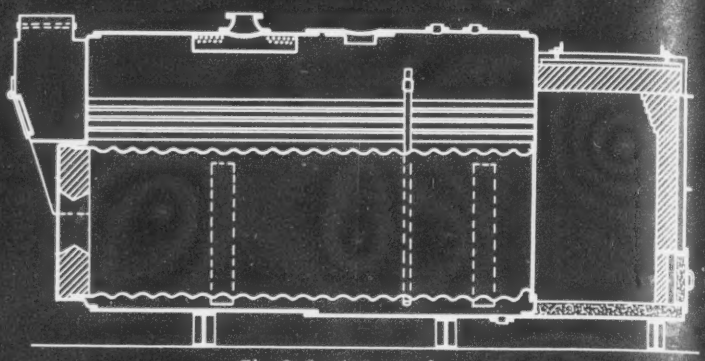


Fig.2-Scotch marine

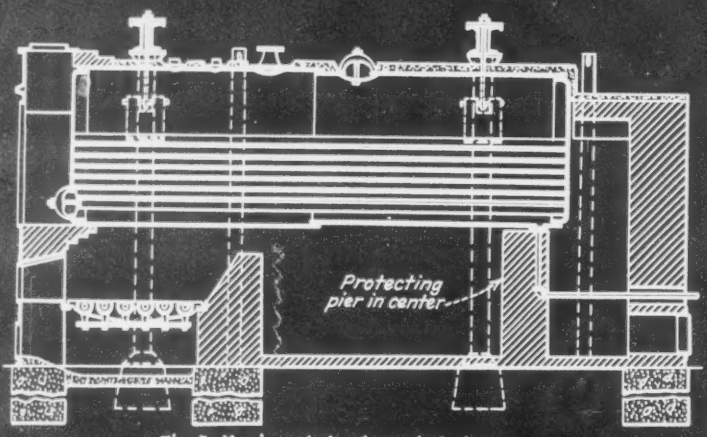


Fig.3-Horizontal return tubular

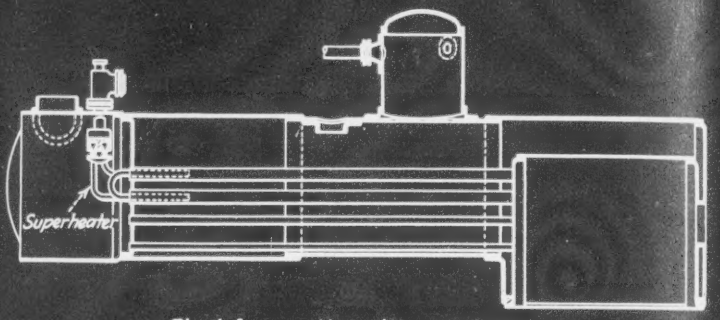
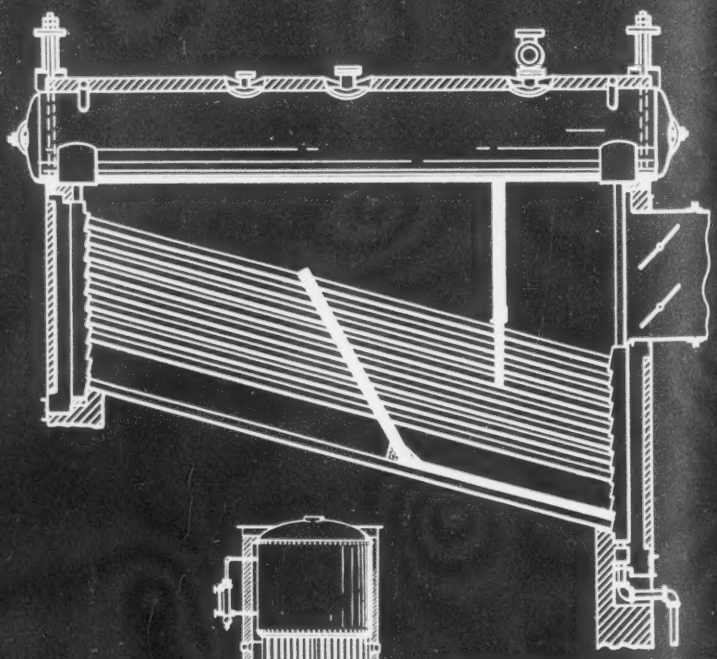


Fig.4-Locomotive with superheater



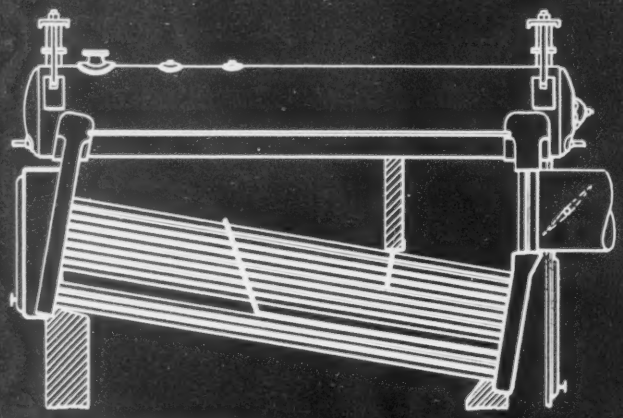


Fig.5-Straight-tube longitudinal-drum box-header

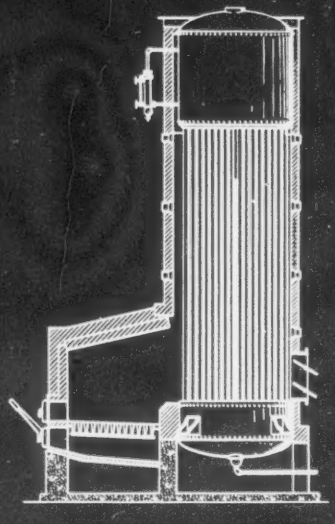


Fig.6-Straight-tube longitudinal-drum sectional-header

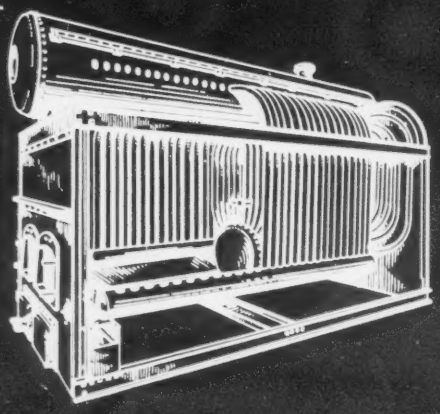


Fig.7-Two-drum bent-tube. One drum half length

Fig.8-Vertical water-tube

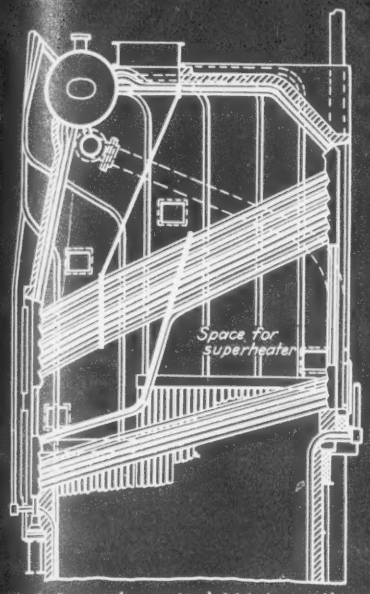


Fig.9-Cross-drum straight-tube sectional-header. Inclined risers

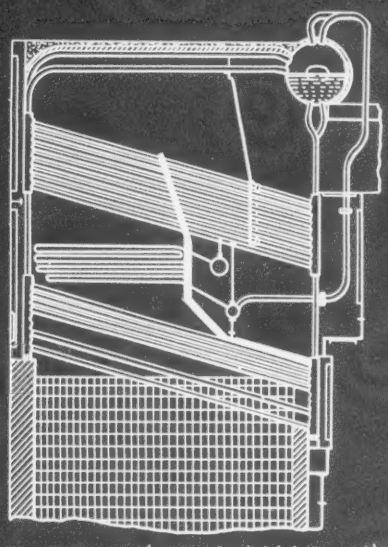


Fig.10-Cross-drum straight-tube sectional-header with slag screen

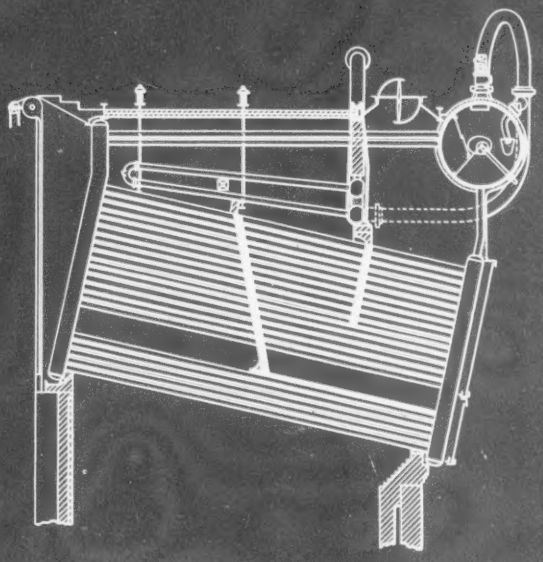


Fig.11-Cross-drum straight-tube box-header

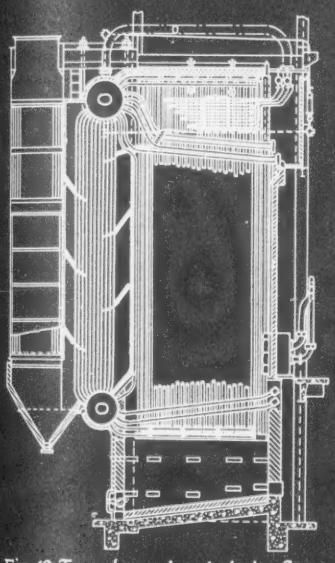


Fig.12-Two-drum bent-tube.Gas flow vertical

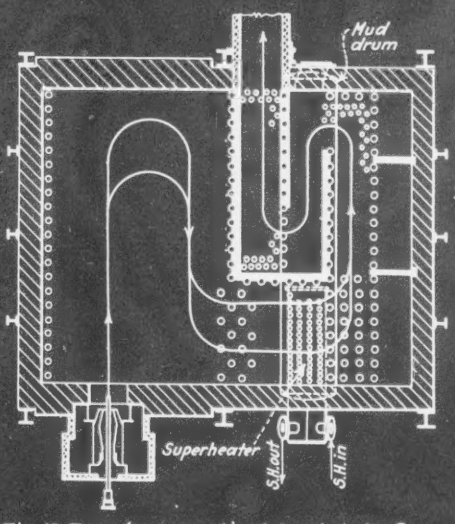


Fig.13-Two-drum vertical-bent-tube.Gas flow in horizontal plane.Two sizes of boiler tubes

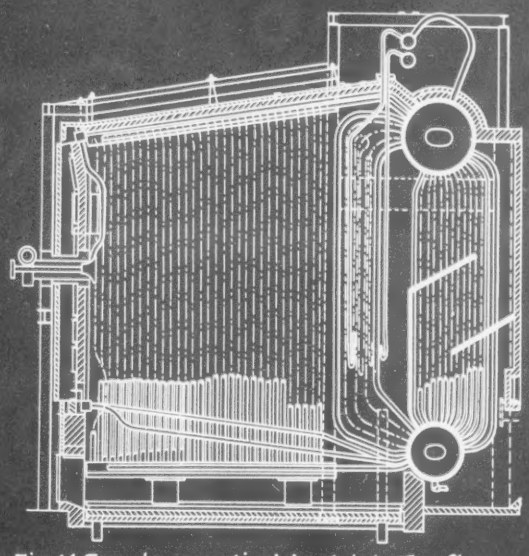


Fig.14-Two-drum vertical-bent-tube.Gas flow in vertical plane.Two sizes of boiler tubes

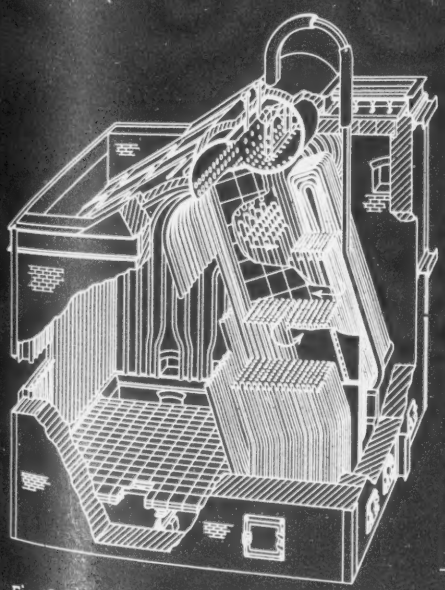


Fig.15-Two-drum inclined-bent-tube.Gas flow in horizontal plane.Two sizes of boiler tubes

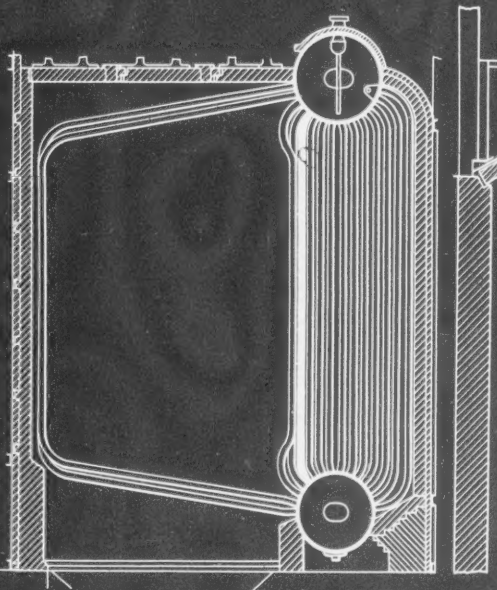


Fig.16-Two-drum vertical-bent-tube.Gas flow in horizontal plane

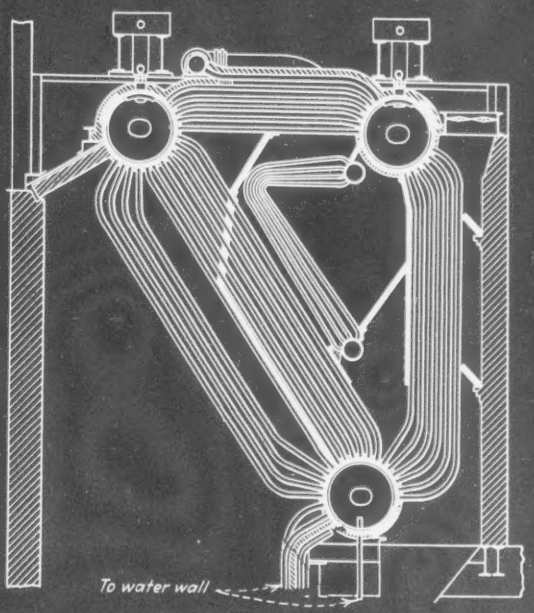


Fig.17-Three-drum bent-tube

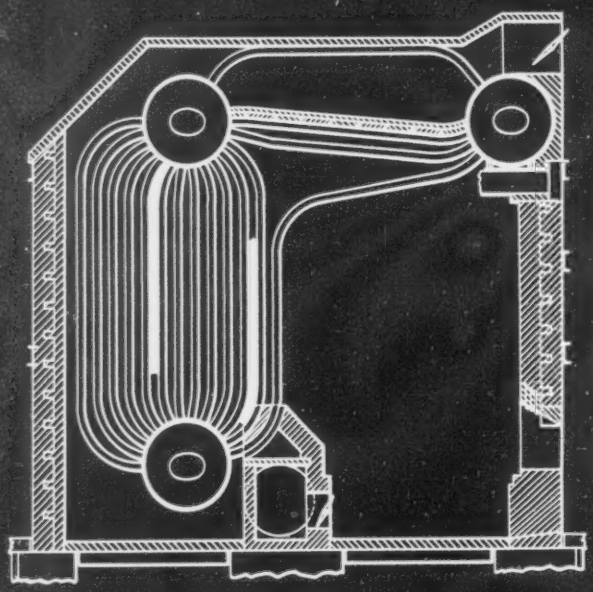


Fig. 18-Three-drum bent-tube, L-shape

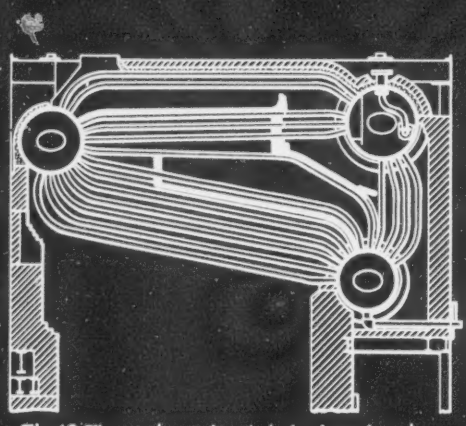


Fig. 19-Three-drum bent-tube low-head

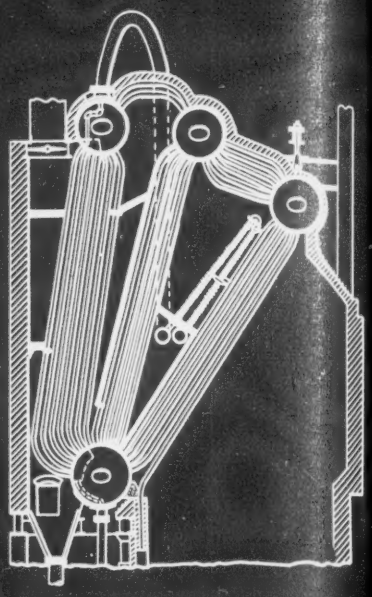


Fig. 20-Four-drum bent-tube. One upper drum submerged

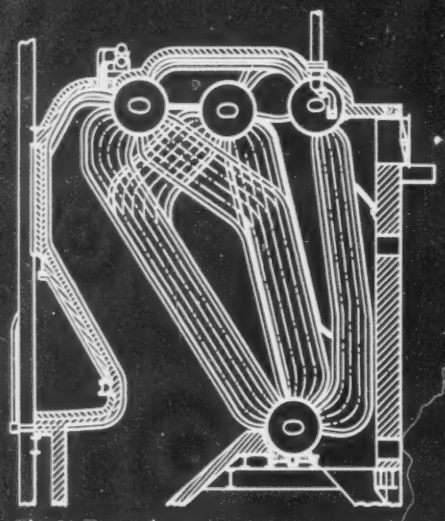


Fig. 21-Four-drum bent-tube cross-tube

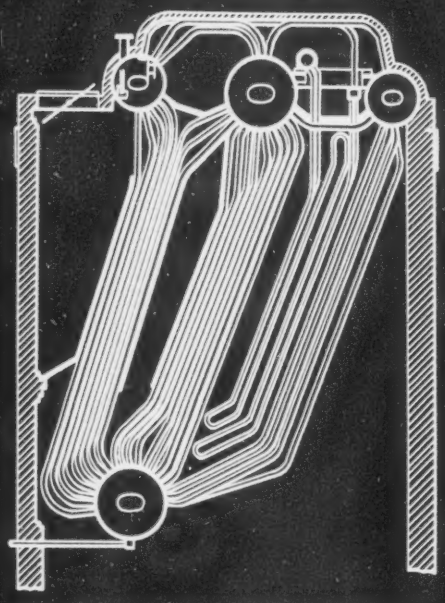


Fig. 22-Four-drum bent-tube with slag screen

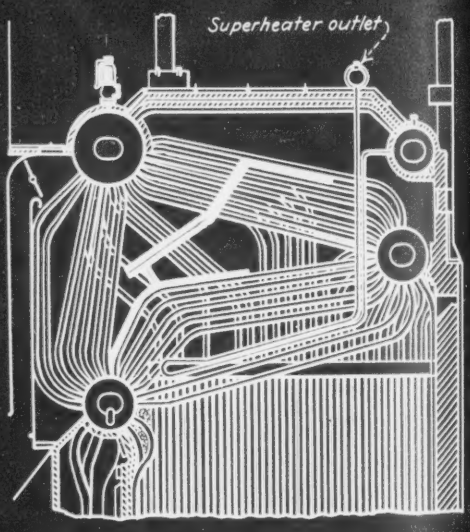


Fig. 23-Four-drum bent-tube. One drum used as steam dryer

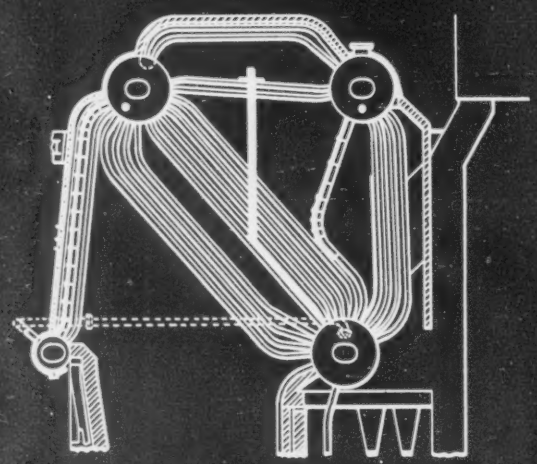


Fig. 24-Four-drum bent-tube. Two drums submerged

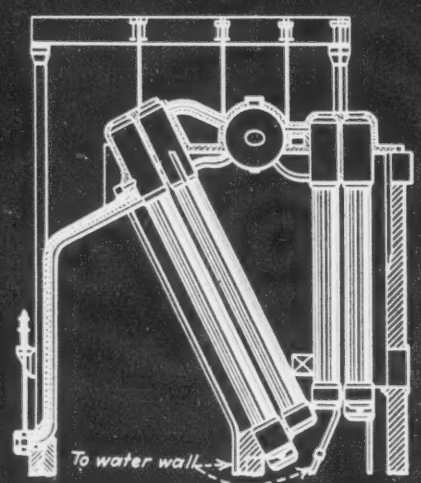


Fig. 25-Vertical and inclined straight-tube

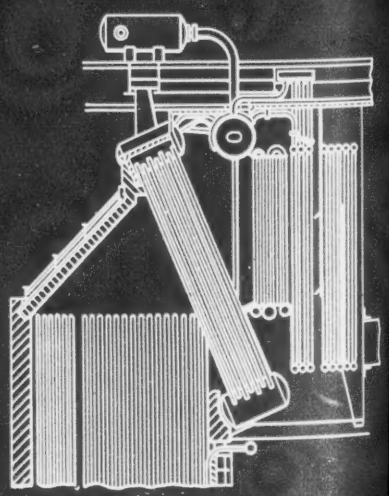


Fig. 26-Bent-tube multi-unit

BOILERS TODAY

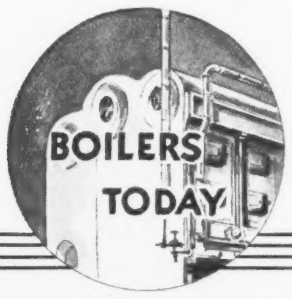
Boilers are the basis of every steam plant, yet few engineers have had the opportunity to become familiar with more than two or three types. To provide a broad picture, this 20-page survey has been prepared by P. W. Swain, editor, and R. B. Purdy, associate editor, with the cooperation of many specialists

MAN'S original idea of a boiler was merely a kettle set over a fire and provided with a connection through which steam could be removed. Advances in engineering knowledge and demands for greater steam capacity have made many progressive changes in boiler design—the present-day boiler is not merely a container in which water may be boiled. Heating surfaces are disposed to remove heat effectively from combustion gases, water passages are arranged to provide water circulation, to increase heat transfer and prevent metal parts of the boiler from overheating, and the furnace has been made a part of the boiler by enclosing it within water walls connected to main boiler circulation. This has made possible higher rates of fuel combustion without excessive maintenance. In fact, general design of a modern boiler goes hand-in-hand with design of the furnace and combustion equipment.

Firing equipment and furnace size should be large enough to burn the fuel at the required rate for efficiency and economy in maintenance, and in new installations width and depth of the boiler are best chosen to meet the dimensions of the furnace. It may well be pointed out here that often a premature decision as to location of building- and boiler-supporting steel limits the free choice of boiler width, depth and height, adversely affecting both first cost and efficiency.

Economies often act in opposition to the dimensions required by combustion considerations. For example, a straight-tube, cross-drum boiler costs less when the tubes are long and the boiler narrow because headers and long drums are costly. For the same reason, a bent-tube boiler costs less when it is narrow and high. Since the manner in which costs vary with length, width and height are known only by the boiler manufacturer, their selection should, as far as possible, be left to him. By asking for several bids, the owner is assured that each manufacturer will suggest the lowest-cost arrangement of heating surface that will produce required capacity at desired efficiency.

Boilers are generally classified as fire-tube or water-tube. Many types exist under each of these classifications, as illustrated in the preceding pages. Boilers shown are standard types; special designs often used in central stations and large industrials are not shown.



The fire-tube type is older than the water-tube, perhaps for this reason is sometimes not looked upon as a modern boiler. Yet such boilers have a definite place and field of usefulness. When provided with proper combustion equipment, they will produce steam efficiently when operated within their specified capacity. Their inherent construction limits both size and pressure. Fire-tube stationary boilers are seldom built for more than 150 lb. pressure or for rated outputs over 15,000 lb. per hr. They are seldom operated at more than 150% rating. These limitations as to size and pressure restrict their use to relatively small plants.

Practically no changes have been made recently in the general design and arrangement of heating surface in the various types of fire-tube boilers. Riveted joints are used almost entirely; welding is not generally used, principally because most manufacturers of this type have not the equipment necessary to X-ray the welds as required by boiler construction codes. An exception is for boilers of this type designed for less than 15 lb. pressure where X-ray is not required.

Large fire-tube boilers are usually horizontal-return-tubular, as in Fig. 3, the largest and highest pressure boiler of this type built so far being 96 in. in diameter and designed for 400 lb. pressure. Tubes in the first pass of H.R.T. boilers are usually 4 in. in diameter to provide sufficient area for gas flow; second-pass tubes are often made less. Fire-tube boilers in general are free steaming and operate well under varying loads because of their relatively large water-storage capacity. Superheaters can be adopted when required. Fig. 4 shows a superheater in a locomotive-type fire-tube boiler. This type is used for portable units, especially around oil wells.

Water-tube boilers may be either straight- or bent-tube. Whether one or the other is used is often determined by individual preference or local space conditions. It is generally admitted that bent-tube boilers handle poor feedwater better than straight-tube types. A difference of opinion exists as to which is best suited for very high pressure, and both types are in service at pressures above 1,000 lb.

A relatively recent change in construction methods permitted by the Boiler Code is the application of welding to boiler drums. Today the seams in boiler drums of all types are welded, riveted construction becoming the exception rather than the rule. At present about $4\frac{1}{4}$ in. is the thickest drum sheet welded. This limit is set not by the Boiler Code, but because present X-ray equipment does not penetrate a greater metal thickness and difficulty of forming a thicker sheet (new equipment is being installed that will X-ray $5\frac{1}{4}$-in.

Welding has decreased the cost of drum manufacture and has largely eliminated the danger of metal embrittlement that has occurred near calked and riveted joints. A more recent change in the Code now permits use of steel having 70,000 lb. tensile strength, as against the previous limit of 55,000 lb.

Straight-tube boilers are either longitudinal-drum, Figs. 5 and 6, or cross-drum, Figs. 9, 10 and 11. Longitudinal- and cross-drum boilers may have box or sectional headers. Box headers are inclined so the boiler tubes are perpendicular to the tube sheet whereas sectional headers may be either inclined or vertical. The box header limits the pressure for which these boilers can be economically built to about 300 lb. Capacity is limited by the connection between the header and the drum. Above about 14 tubes wide, two drums are required, and since drums are expensive cross-drum boilers are usually used for larger capacities.

There are no such pressure limitations for cross-drum sectional-header boilers, manufacturers being ready to build them to operate at 2,500 lb. per sq.in. Likewise double-set cross-drum boilers have been built that have delivered over 1 million pounds of steam per hour. There is, however, a limit to the steaming capacity per foot width of boiler for a given pressure and number of circulators and tube length. Each section is seldom more than 24 tubes high, though horizontal cross-drum boilers 43 tubes high have been built. The trend is to decrease the height of boiler as much as possible and to add heating surface in the water walls and economizer. This trend is well illustrated by Fig. 27, a recent central-station boiler only 6 tubes high. The drum has been placed very high above the tubes to make room for superheater and economizer.

Final steam temperature largely determines the location of the superheater, hence the general boiler arrangement. Ordinarily, higher temperatures dictate the use of an interdeck superheater, while for lower temperatures there may be a choice between a superheater at the top of the first pass or a smaller interdeck superheater. Space required to accommodate superheater surface is so great that it becomes necessary in many instances first to design the superheater, then to consider the boiler. Superheaters are treated in greater detail later in this section (page 636).

There is a trend to the use of tubes bent to support or form water-cooled baffles, in Figs. 9 and 27. This increases the life of the baffles and makes them easier to install.

Low- and medium-pressure straight-tube boilers usually have 4-in. diam. tubes. An exception is the boiler in Fig. 9, using 3-in. diam. tube header, details of which are shown on page 644. Above about 500 lb., some manufacturers reduce tube size to $3\frac{1}{2}$ in. and to $3\frac{1}{4}$ in. for pressures above about 900 lb. Heat transfer is somewhat better with small tubes, but as tube diameter decreases the number of headers required in a boiler of given surface increases. Headers are costly, hence the 4-in. diameter in the medium-pressure range. But as pressure increases, metal thickness in both tube and header must increase, which adds to manufacturing expense. Hence to reduce the increase in metal thickness, tube diameter is often decreased for high pressures. Maximum tube length for straight-tube boilers is between 24 and 26 ft., 18 to 20 ft. being about standard.

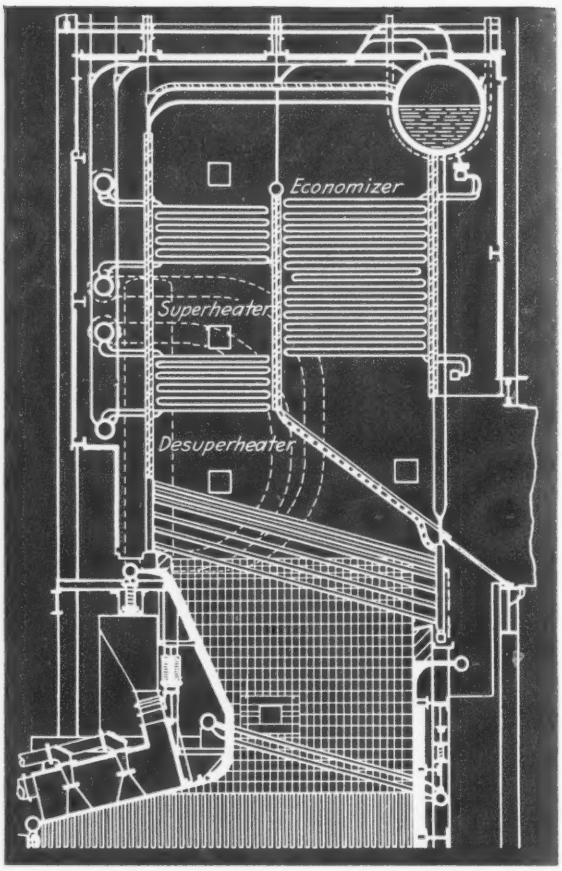
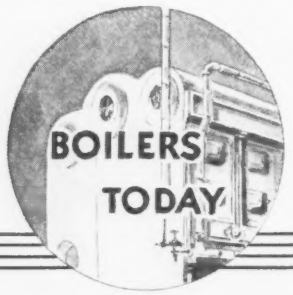


Fig. 27—Recent cross-drum unit, showing use of slag screen and water-cooled baffle

High furnace temperature and high steaming rates per square foot of boiler surface demanded of modern boilers has resulted in difficulty from molten ash sticking to the first and second rows of boiler tubes, clogging up the gas passage and reducing capacity to such an extent as to force shutdowns for cleaning. To overcome this, slag screens have been formed by dropping every other tube in the first row, as in Fig. 10. Another method is to bend down every other first-row tube. Both methods result in increased spacing between tubes. Molten ash will not generally bridge across the wider spacing, and usually falls after a certain thickness is reached. Hence the gas passages are not clogged to the same extent. A more recent arrangement used with slag-tap furnaces is shown in Fig. 27, where a slag screen consisting of refractory-covered tubes has been placed across the furnace a considerable distance below the boiler. Its main purpose is to shield the boiler tubes from the radiant heat of the high temperatures required



to keep the ash molten. Some ash is caught on these tubes, where it accumulates to a certain thickness. Any additional ash becomes molten and drips off.

Bent-tube boilers lend themselves to a greater variety of arrangements than does the straight-tube boiler, and some of these variations are shown in Figs. 12 to 24. They vary all the way from 2-drum boilers to 4-drum units. Even 5- 6- and 8-drums are used in special high-capacity tailor-made units for central stations and large industrials. Typical special arrangements, some of which have produced over a million pounds of steam an hour, are shown in outline by Fig. 28, but because they are special they will not be discussed further. 4-in. tubes are not used in bent-tube boilers, largely because of decreased ligament efficiency with increased diameter and the consequent increase in drum-wall thickness. Below 500 lb. per sq.in., $3\frac{1}{4}$-in. tubes are usually used; above this pressure some manufacturers drop to 3-in. tubes. More recently, 2-in. diam. tubes appear in certain designs.

Starting with the 2-drum type, the most recent developments are shown by Figs. 12 to 16. Here the completely water-cooled furnace is an integral part of the boiler and the boiler is engineered from the furnace requirements. Both $3\frac{1}{4}$- and 2-in. diameter tubes are used. The larger-diameter tubes are used in the first pass because more steam is produced there and larger tube area is necessary both to take care of circulation and the greater likelihood of scale. Spacing between these tubes in the first few rows is greater so they will act as a slag screen. 2-in. tubes are used in the second and third passes because more heating surface can be obtained in a given space and heat transfer per square foot is improved by closer tube spacing. Less steam is generated in this section, hence less scale forms and the tubes can safely be made smaller. Gas flow is parallel to the boiler drums in Figs. 13, 15 and 16, while in other units of this type baffles force the gas to zigzag through the tube banks vertically.

Fig. 7 illustrates another 2-drum boiler of new design. The bottom drum is only half the length of the top drum.

Modernization of old boiler rooms has brought a demand for efficient boilers that can be installed where headroom is limited. The 3-drum, low-head boiler, such as Figs. 18 and 19, has been the answer to this demand. By decreasing headroom required by the boiler, more adequate furnaces can be constructed in a given available height. These boilers are usually good for about 250% rating, are rather difficult to baffle, and heating surface per foot of width is low. Although the boilers illustrated are designed for saturated steam, space for superheaters is easily provided.

Above about 5,000 sq.ft. of heating surface, 3-drum boilers are usually arranged similar to Fig. 17. The longer tubes permit greater capacity per foot of width. In general, when the bent-tube boiler generates high-pressure (1,000 lb. or more) steam, the 3-drum type is used rather than the 4-drum, high cost of high-pressure drums being the principal reason.

Four-drum boilers such as in Figs. 20 to 24 are used when pressure is less than about 900 lb. and for large capacity. Considerable variation exists in the elevations at which the three upper or steam drums are placed. In some designs, all steam drums are at the same, or nearly the same, level whereas in others one of the upper drums operates completely submerged. Boilers of both types give satisfactory performance.

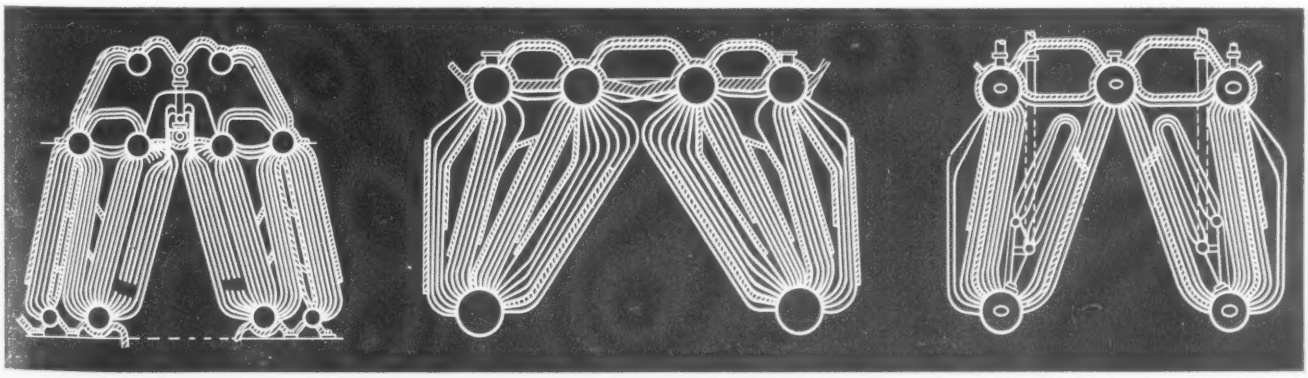
Baffles, shown dotted in Fig. 20, are often included in the back steam drum and mud drum. These baffles force feedwater to circulate down in the four back rows of tubes, up in the next two rows and down in the remaining row. This not only gives an economizer effect but also provides positive circulation of water in the last row of tubes where circulation usually is lazy. In one boiler, feedwater is admitted to a header which feeds a single row of tubes rolled into the mud-drum at their other ends in addition to internal drum baffles similar to those just described. Another means to improve circulation in the last bank of tubes is shown in Fig. 22, where some of the tubes are rolled into the middle steam drum instead of back steam drum.

In Fig. 21, alternate tubes in the front bank are rolled into the middle drum, and alternate tubes of the middle bank are rolled into the front drum. Since the front bank generates considerably more steam than the middle bank, steam released in the two drums is more evenly distributed, permitting smaller-diameter drums or better steam separation. Likewise the ligaments between tubes are larger, permitting thinner drums. Also, the steam circulating tubes from the front drum lead steam to the back drum direct.

In Fig. 23, the top front drum acts as a steam separating or drying drum and is not a part of the boiler circulation. Superheater tubes are rolled directly into this drum.

Boiler tubes in the past have generally been either lap-welded or seamless steel or lap-welded wrought iron. In 1932 the Code Committee expressed the opinion that electric resistance—welded tubes may be considered to meet Code requirements if they pass the required tests and specifications.

Fig. 28—Multi-drum bent-tube boilers used for large capacities



OPERATION

BOILERS usually require much less attention than does combustion and auxiliary equipment, but the attention it does require is vitally important. Operating procedure cannot be detailed in the short space here available, but main points can be mentioned, and the accompanying bibliography lists many full-length articles on boiler operation.

Water level must be maintained as constant as possible, for safety sake. When you enter a boiler room, first find out whether piping and valves between boiler and water glasses are free and open by blowing down the water columns and gage glasses and trying the gage cocks. Never depend upon automatic alarms for feedwater regulation.

If water level drops below the water glass, stop the supply of air and fuel, close damper and ashpit doors, unless you are certain of feedwater supply and positive that it is safer to continue steaming the boiler. If fuel and air are stopped, do not change feedwater supply, open safety valves or change steam-outlet valve or any other adjustment that will cause sudden change or stress on the boiler.

Treat feedwater according to instructions; do not experiment with "home-made" treatments or boiler compounds.

Except where amount and frequency of blowdown are determined by chemical analysis, blow down at least one full opening and closing of the blow-off valve every 24 hr. Blow down when steam production is lowest. Always open cock or quick-opening valve first and blow-off valve second, then close blow-off valve first.

When small leaks occur, locate and repair them as soon as the boiler can be taken out of service. If a serious leak occurs, such as along a drum seam or near a flange or drum head, shut down the boiler immediately by gradually reducing steam pressure, then have boiler examined.

If a tube fails, shut off air supply, keep damper open, check fire and shut stop-valve. Maintain feedwater supply until brickwork has cooled enough to prevent injury to the boiler through overheating.

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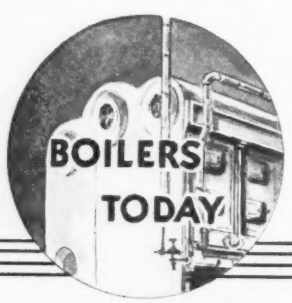
KEY:

P—POWER
M.E.—"Mechanical Engineering"
T—A.S.M.E. "Transactions"



POWER BOILERS—TYPES, MANUFACTURERS

Listing Checked by Manufacturer	Maximum Figures For Usual and Occasional Practice (2)		GENERAL TYPE OF BOILER (1) — FIRE-TUBE: Horizontal Return Tubular	Firebox H.R.T.	Scotch Marine	Locomotive (stationary)	Vertical	Special Design Horizontal, Internally Fired	Special Design Horizontal, Externally Fired	WATER-TUBE: Horizontal, Straight-Tube Longitudinal-Drum	Horizontal, Straight-Tube Cross-Drum	Vertical Straight-Tube, 2-Drum	Bent-Tube, 2-Drum	Bent-Tube, 3-Drum	Bent-Tube, 4-Drum	Inclined Straight-Tube	Bent-Tube, 3-Drum Express	Bent-Tube, 4-Drum with Radiant Element	Bent-Tube, Self-Contained Unit, Two or More Drums	Double-Set Bent-Tube with Five or More Drums (3)
	Water heating surface, sq. ft.	Usual Maximum	2,000	2,000	3,000	2,000	1,500			8,000	20,000	5,000		10,000	15,000	6,000	8,000	5,000	10,000	
		Occasional Maximum	4,000	3,000	3,500	2,500	3,500			15,000	40,000 (5)	6,000		45,000	25,000	30,000	12,000	15,000	15,000	
	Capacity lb. steam per hr.	Usual Maximum	8,000	6,000	10,000	7,000	5,000			100,000	300,000			150,000	200,000	25,000	100,000	50,000	100,000	
		Occasional Maximum	20,000	10,000	15,000	13,000	12,000			150,000	600,000 (5)		150,000	700,000	450,000	150,000	150,000	200,000	150,000	1,250,000
	Operating pressure lb. per sq. in.	Usual Maximum	150	150	200	200	150			350	750	250	250	400	450	250	400	250	400	
		Occasional Maximum	350	200	250	350	200			450	1,400 (5)		600	1,400	900	500	650		800	1,400
	Almy Water Tube Boiler Co., Providence, R. I.									X	X									
*	Ames Iron Works, Oswego, N. Y.		X	X		X	X			X	X			X(4)	X		X		X	X
*	Babcock & Wilcox Co., New York, N. Y.									X	X	X		X(4)	X					
*	Bass Foundry & Machine Co., Fort Wayne, Ind.		X											X(4)	X	X				
	Bigelow Co., New Haven, Conn.		X	X	X		X													
*	Broderick Co., Munice, Ind.					X								X	X				X	
*	Wm. Bros Boiler & Mfg. Co., Minneapolis, Minn.		X	X	X	X	X													
	Brownell Co., Dayton, Ohio		X	X	X	X	X			X	X		X	X(4)	X		X		X	X
*	Combustion Engineering Co., New York, N. Y.		X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
*	Edge Moor Iron Co., Edge Moor, Del.		X	X	X		X			X	X		X	X(4)	X					
*	Erie City Iron Works, Erie, Pa.		X		X		X													
*	Farrar & Trefts, Buffalo, N. Y.		X	X	X		X													
*	Fitzgibbons Boiler Co., Inc., New York, N. Y.		X		X						X		X	X(4)	X		X	X	X	X
*	Foster Wheeler Corp., New York, N. Y.																			
*	Gem City Boiler Co., Dayton, Ohio				X															
*	Hamburg Boiler Works, Hamburg, Berks Co., Pa.						X													
	Hodge Boiler Works, E. Boston, Mass.		X	X	X	X	X									X				
*	International Boiler Works, E. Stroudsburg, Pa.		X	X	X	X	X	X	X	X	X	X	X	X	X					
*	International Engr. Works, Framingham, Mass.		X	X	X	X	X													
*	Johnston Bros. Inc., Ferrysburg, Mich.		X	X	X	X	X			X	X			X(4)	X				X	
*	E. Keeler Co., Williamsport, Pa.		X		X															
*	Kewanee Boiler Corp., Kewanee, Ill.		X	X		X													X	
*	Kroeschell Boiler Co., Chicago, Ill.		X	X	X	X	X			X	X		X	X	X				X	
	Lasker Boiler & Engr. Co., Chicago, Ill.		X	X	X	X	X													
*	James Leffel & Co., Springfield, Ohio.		X		X															
*	Murray Iron Works, Burlington, Ia.		X	X	X	X	X	X	X	X	X		X	X(4)	X	X				
*	Pierce, Butler & Pierce Mfg. Co., Syracuse, N. Y.		X	X	X	X	X						X	X(4)	X				X	
*	Riley Stoker Corp., Worcester, Mass.										X			X(4)	X		X			
*	Springfield Boiler Co., Springfield, Ill.																			
*	Stanwood Corp., Cincinnati, Ohio		X	X		X													X	
	Steam Generator Corp., Chicago, Ill.																			
*	Titusville Iron Works Co., Titusville, Pa.		X	X	X	X	X	X	X	X	X		X	X	X	X				
*	Tudor Boiler Mfg. Co., Cincinnati, Ohio		X				X			X						X				
*	Union Iron Works, Erie, Pa.		X	X	X	X	X		X	X	X		X	X(4)	X			X	X	
*	Henry Vogt Machine Co., Louisville, Ky.		X		X		X			X	X		X	X(4)	X				X	
*	Wickes Boiler Co., Saginaw, Mich.		X		X					X	X	X		X(4)	X		X			

Notes

(1) This table includes only boilers which the manufacturer reports he can supply in sizes above 1,000 sq. ft. and pressures above 151b.

(2) Complete consistency is impossible in this data section.
It should not be inferred that all manufacturers can furnish the indicated usual maximum size or pressure.
In large units, particularly those with large radiant surface and economizers and air heaters, the heating surface figures are of little significance.

(3) Made in large sizes only.

(4) Including low-head types.

(5) These limits apply to sectional-header boilers only.

A Glimpse of the

DESIGNER'S PROBLEM

THIS is addressed to boiler users, not designers. It cannot show the user how to design a boiler—that is a life-long study—but it will, we hope, give him added understanding of the designer's problems and expedite cooperation, to the great advantage of everybody concerned. Because there have been few recent changes in fire-tube boilers, the article will deal almost exclusively with water-tube boilers.

Leaving out innumerable special boilers, the development of modern water-tube boilers has followed two main lines. One is that of the horizontal water-tube boiler with longitudinal drum or cross drum, and with box or sectional headers. Cross-drum, sectional-header units are built commercially up to very large sizes and for all pressures up to 1,400 lb., and can be built for pressures as high as 2,500 lb.

An entirely different development is represented by the 2- to 5-drum bent-tube boiler now made in numberless shapes and forms. The largest boiler in the world, as well as that employing the highest commercial steam pressure (1,800 lb.) is of this type. Typical forms of boilers, both fire-tube and water-tube, are described and illustrated on pages 626-631.

Before 1920, boilers had been running along with a maximum capacity of perhaps 150% of rating, evaporating about 5 lb. of water per sq.ft. of water-heating surface per hour. Then several new factors—notably rapidly rising utility loads and the advent of pulverized fuel—led to the demand for more work from a given tonnage of boiler metal.

In 1923, a boiler of the latest type at Ford's River Rouge station had 26,470 sq.ft. of heating surface. It carried 225 lb. pressure, operated at 80% efficiency, and produced approximately 6 lb. of steam (maximum) per sq.ft. of heating surface. Today, another River Rouge boiler is being erected, a 30,000-sq.ft., 1,400-lb. unit, generating peak loads of 30 lb. of steam per sq.ft. of water-heating surface, 900,000 lb. of steam per hour. Efficiency now is 87%.

Of course, the boiler proper is not responsible for all these gains. If one speaks, loosely, of "ratings," the 30,000 sq.ft. of water-heating surface is credited with all of the 900,000 lb. of steam produced. But the steam-producing unit contains also 22,300 sq.ft. of superheater, 26,500 sq.ft. of economizer, 86,000 sq.ft. of air heater and 9,500 sq.ft. of water wall and screen.

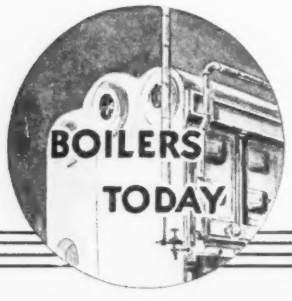
Once a boiler was a boiler. It was no particular concern of the boiler builder how it was fired, how the furnace was constructed or what was done about a superheater or economizer. Today competition and rapidly developing technique have forced him to guarantee also the capacity, efficiency, exit-gas temperature, draft loss, superheat and pressure drop, coordinating all of these with all the equipment, other than the boiler proper, that goes to make the boiler unit.

In spite of the tremendous amount of scientific data available, no boiler can be designed properly on theory alone. Theory is an essential tool of the boiler designer, but at every step it must be tied in with experience on models and full-size commercial boilers. How, then, can the designer design? It is possible here to touch only the high spots.

Modern boiler design is based largely on "mass flow" of gases and steam. Knowing how much steam must be produced, the approximate efficiency of the boiler unit and the heat value of the fuel, you can say how much fuel must be burned per hour. Next you can estimate, from previous experience with the same fuel and firing method, what percentage of excess air will probably be used. Weight of fuel and air supplied enable you to compute the quantity of hot gases flowing through the furnace and into the boiler. So far the road is fairly smooth.

The next step is extremely difficult. What will be the furnace temperature? (See page 470, *Sept. Power.*) It is easy to figure the theoretical temperature of the combustion products, assuming a given excess of air, but this theoretical temperature bears little relation to that actually produced in the furnace, because the heated refractories, the mass of hot fuel (if the boiler is stoker-fired), the incandescent particles of pulverized fuel, or the luminous flames of gas and oil, radiate heat directly to any boiler tubes that can "see" them. Other things being equal, the greater the square footage of water-cooled surface exposed to this radiation, the lower will be the furnace temperature. This temperature must be adjusted to suit the limitations imposed by firing method, ash-fusion temperature and permissible carbon loss in fly ash.

After the gases have penetrated the boiler to a point where the tubes can no longer "see" any luminous objects or particles, heat transfer becomes a simpler, but not a simple, problem. The designer, now dealing with "convection," has worked out formulas for gas flow through banks of tubes of given size and

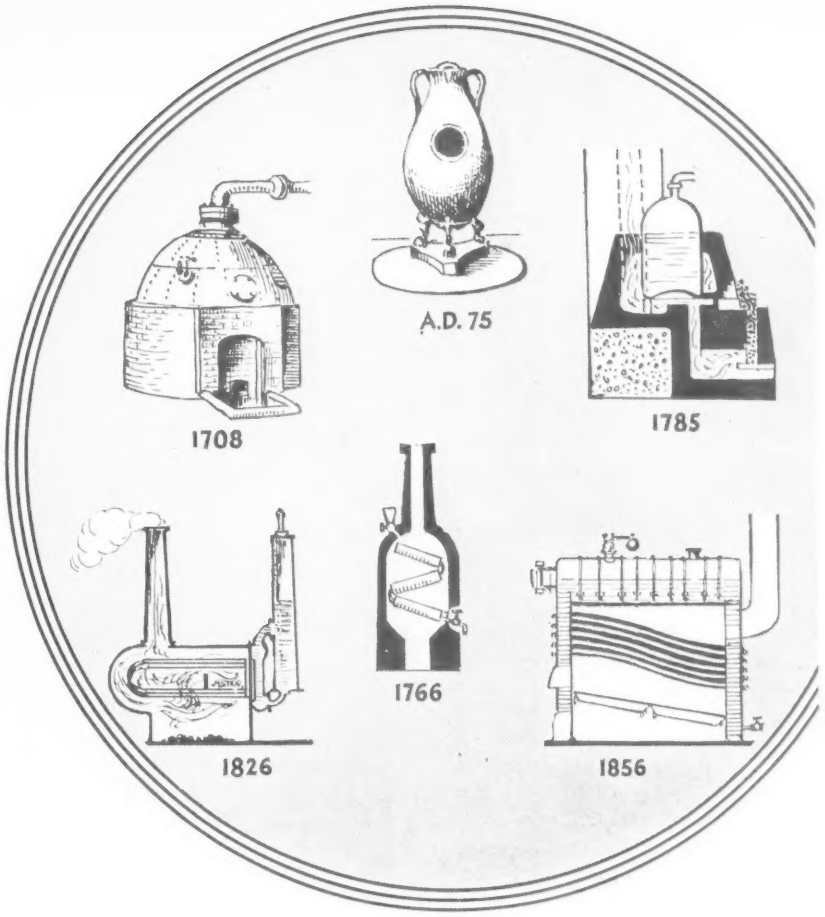


spacing, which tell how much heat will be transferred, provided he knows the mass flow of gas, its temperature, the temperature of the metal surface, etc. Even here many corrections must be made.

Both theory and practice show that the tail end of the ordinary boiler was a loafer—did little work. Of all the tonnage of steel in boiler tubes, the tail end 50% did less real work than the first 5%. Yet the 50% was put there, not because it was worth while to pay so much for a slight increase in steam generation, but to keep efficiency from dropping out of sight.

The modern tendency is to "throw away" the 50%, leave exit gas at a fairly high temperature and then reduce its temperature at reasonable cost by large areas of less-expensive economizer and air-heater surface. This is especially true in high-pressure installations.

Boiler tubes are sometimes a problem. Where high pressures are associated with high capacities, the necessarily thick tubes exposed directly to furnace radiation must transfer enormous quantities of heat per square foot. That means high outside temperatures, particularly if there is a thin coat of scale inside. At a heat absorption rate of 100,000 B.t.u. per sq.ft. per hour, a mere 1/100-in. thick scale film will raise metal temperature anywhere from 100 to 400 deg. That is why no slightest amount of scale can be tolerated in a modern high-pressure, high-capacity boiler, or in any boiler with high-capacity water walls.



The boiler designer, like every other designer, has to meet specifications expressed in terms of final results. He must produce a unit which will deliver a given normal and maximum weight of steam per hour, at a given pressure and temperature, with lowest possible combined fixed and operating charges and minimum maintenance and outage. Frequently his boiler unit must squeeze itself into an existing boiler house, built for older and smaller units. For some years the demand for low, yet modern, steam-generating units has been insistent, and from this demand has developed a variety of low-head steam producing units which promise to revolutionize steam generation, particularly in medium-size industrial plants.

To insure dry steam at high evaporations, some designers set one drum well above the other and carry steam alone to it to remove water. Others insist that the proper solution is a steam dryer, or combined dryer and washer, within the drum itself. These are discussed on page 642. Steam dryers and washers, plus automatic feed control, permit smaller drums and appreciable savings in first cost.

The matter of boiler circulation is highly controversial. All agree, however, that rapid circulation is essential and that it is produced mainly not by the fact that hot water is lighter than cold, but by the fact that a mixture of water and steam bubbles is very much lighter than water alone.

It would not be proper to conclude these remarks on boiler design without mentioning the wonderful work done by the A.S.M.E. Boiler Code Committee. Organized in 1911, it has developed a set of rules for boiler construction, which are now law in 23 states and territories and 21 cities. It is significant that this properly conservative body authorized complete welding of power boilers in the 1931 Code. Ample safeguards were set up, notably the requirement that welded seams in drums be X-rayed, and that welded drums be stress-relieved. Today welded boiler drums are considered entirely safe for even highest pressures.

In the simple, every-day routine of boiler construction, whether riveted or welded, the Code has also had profound influence. Today reputable boiler manufacturers do less pounding and more machining. Caulking edges are machine planed. The driftpin is in disrepute. Drums are rolled to a true circle before being welded or riveted.

From his own selfish angle, the boiler user will see the advantage of giving the designer all pertinent information, and at the same time not tie his hands on non-essentials. With this in hand, the designer will go through a process of cut-and-try to give the buyer the most boiler for the least money.

SUPERHEATERS

THE job of the boiler is to produce dry-saturated steam. The superheater takes this steam and raises it well above the saturation temperature.

Diameter, thickness, length and material of tube, shape and arrangement of loops, supply of steam to tubes, protection against overheating and oxidation, space, positioning and support, room for expansion, provisions for removal — all these are important in superheater design.

In general, there are two types of superheater tubes: smooth and extended-surface, the latter having cast-iron fins or gills shrunk upon a smooth tube. Return bends may be of two types—one an ordinary constant-radius pipe bend, the other drop-forged. This construction is associated also with ball-and-socket detachable joints at superheater headers, whereas the other type generally has its tube ends rolled into a steam drum or superheater header. Where two headers are used, flow in saturated and superheated headers should be in opposite directions to insure equal pressure drop across all elements.

Ordinarily, the tube in a single superheater section is bent to lie in one plane and is inserted in a vertical space between tubes, or in an open space between tube banks. The element itself may have many forms.

Superheater design must insure the desired superheat, avoid excessive pressure drop, and avoid great temperature variation from low load to high. The first two are matters of proportionating and placing. The last involves also the following basic principles:

In a superheater heated only by convection, steam temperature rises with load. The reason is obvious. If the load doubles, twice as much steam passes through the superheater, but this is more than offset by higher gas temperatures and doubled gas velocity.

The effect of load change is reversed in a superheater heated only by radiant heat. When boiler load is doubled, radiant heat delivered to the superheater does not double, so steam temperature falls.

While a radiant and a convection superheater can be connected in series to produce a practically flat temperature-load curve, it is more common practice to use a single superheater placed to receive part of its heat by radiation and part by convection. The trick is to locate it where the two types of heat transfer operate in the proper proportions.

If the superheater is in an interdeck space, the point is to place it behind the proper number of rows of boiler tubes. A single superheater element may extend through several gas-temperature zones, as shown in Fig. 9, with the same net effect.

In designing and locating a superheater it is not enough to know the design of the boiler. The amount of water-cooled area exposed to direct radiation, kind of fuel, amount of excess air, draft and range of boiler operation must also be considered. The superheater must be so placed as to avoid slagging at any time or overheating in starting up. Baffle location (see page 641) also is a matter of prime importance.

With steam temperatures of say 850 deg. F. and up, superheater designers encounter problems of considerable difficulty, particularly at high steam pressures and with large-diameter tubes. Both require a thick-walled tube, giving a higher outside metal temperature for a given inside metal temperature. Yet increasing the thickness beyond a certain point will not increase the strength, but will actually weaken the tube by overheating the outer surface.

The limiting temperature of a carbon-steel superheater is a function not only of the desired steam temperature, but also of the unbalance between steam flow and gas flow in various sections. In any sections where inside metal temperature exceeds 950 deg. F., tubes of chrome nickel or chrome molybdenum alloys are used. These are available to withstand inside metal temperatures as high as 1,200 deg.

Exact Control of Superheat

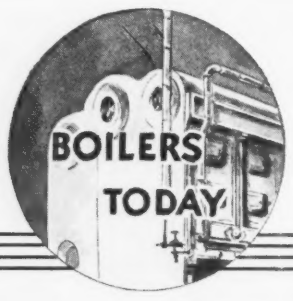
Safety margins become less as steam temperatures go higher, requiring closer control of steam temperature. Conversely, closer control permits a higher steam temperature with safety. An absolutely flat temperature-load curve may be obtained by various mechanical devices. Buzzard Point Station, for example, connects two superheaters in series, with a desuperheater between. A thermostatically controlled bypass around the desuperheater maintains constant temperature at the outlet of the second superheater.

One simple type of control involves special baffling and dampers whereby any desired part of the gas flow can be bypassed around the superheater. Still another, preferred by many engineers, is the compensating superheater. In its most common form, this is a single superheater split into two unequal parts by the boiler baffling. Gas flow through the two parts of the superheater traces two paths through the boiler. Dampers apportion the gas flow between the two paths and thus permit exact control of superheat.

Starting up of a boiler may impose very severe conditions on a superheater located in a hot zone unless an artificial steam flow is provided from another boiler or by bleeding steam from the superheated steam header.

Particularly at high temperatures, superheaters require careful support by clamping one coil to the next, or otherwise, to avoid warping or sagging.

Only a limited number of superheaters are shown on these pages, since a considerable variety of forms and positions are included in the boiler drawings on pages 626-628.



TYPICAL SUPERHEATER APPLICATIONS

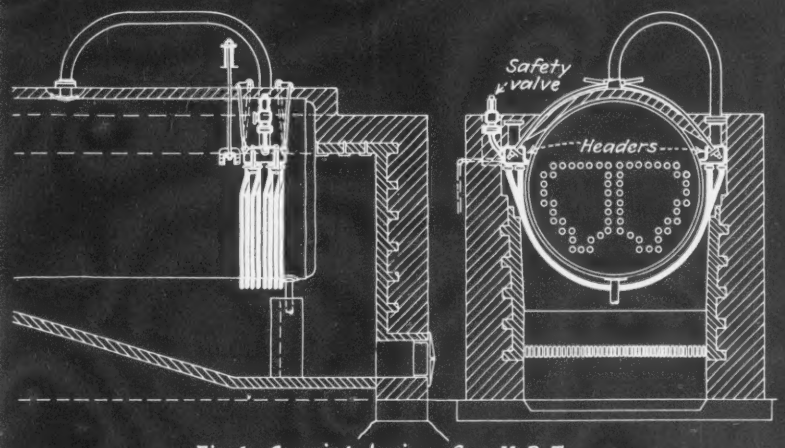


Fig.1 - Special design for H.R.T.

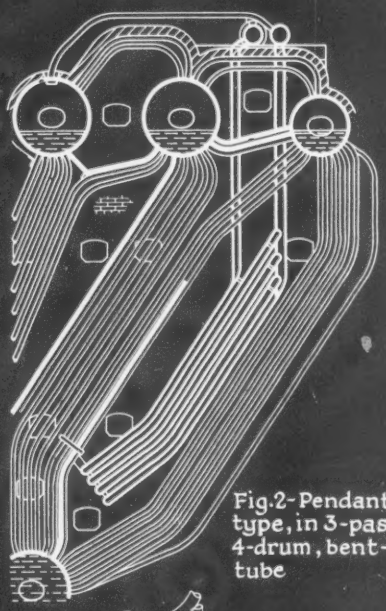


Fig.2 - Pendant-type, in 3-pass, 4-drum, bent-tube

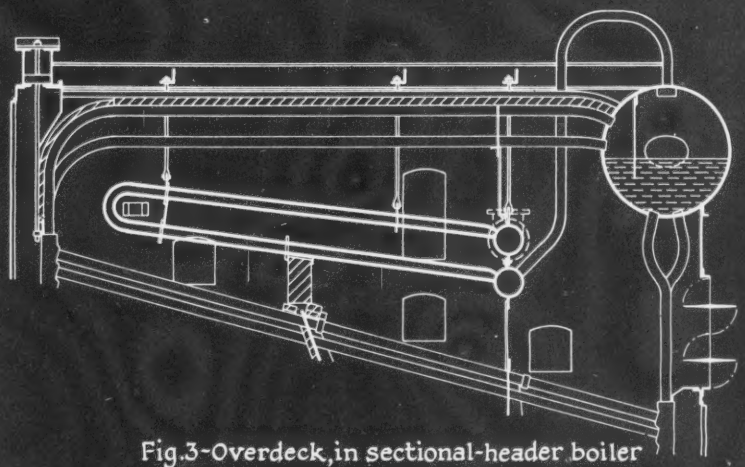


Fig.3 - Overdeck, in sectional-header boiler

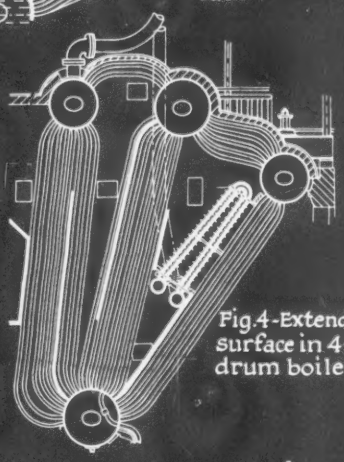
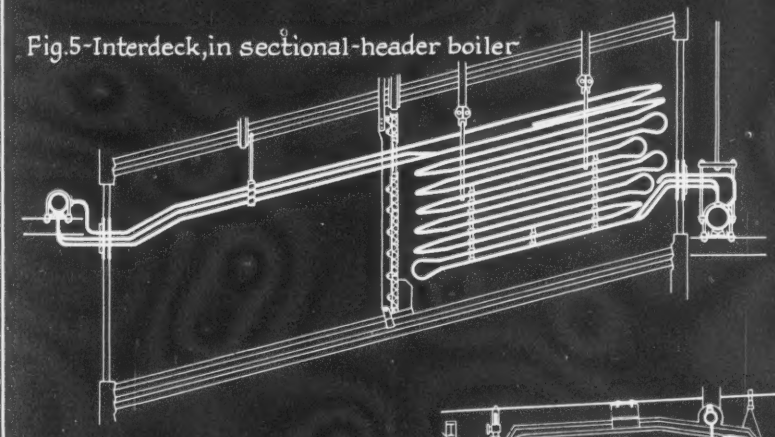


Fig.4 - Extended-surface in 4-drum boiler

Fig.5 - Interdeck, in sectional-header boiler



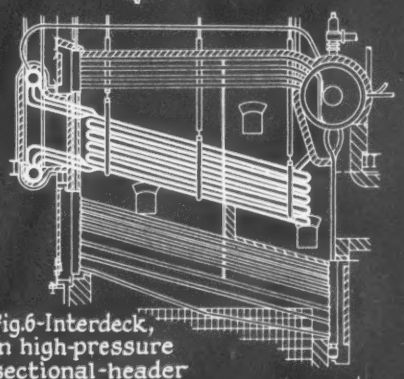


Fig.6 - Interdeck, in high-pressure sectional-header

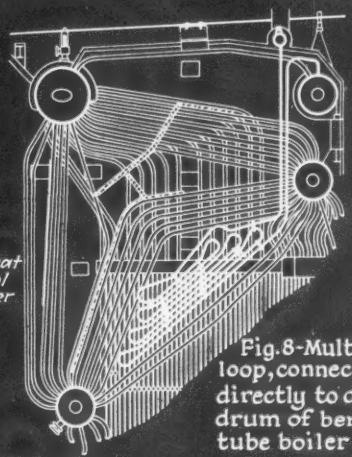


Fig.8 - Multiple-loop, connected directly to dry drum of bent-tube boiler

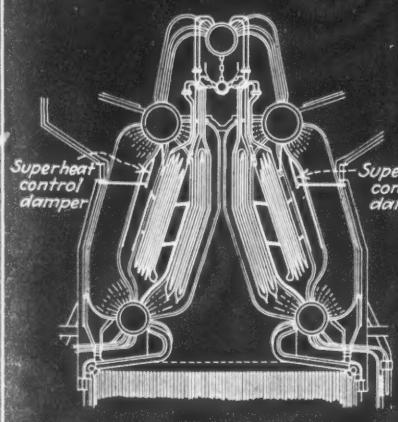


Fig.7 - Damper-controlled superheat

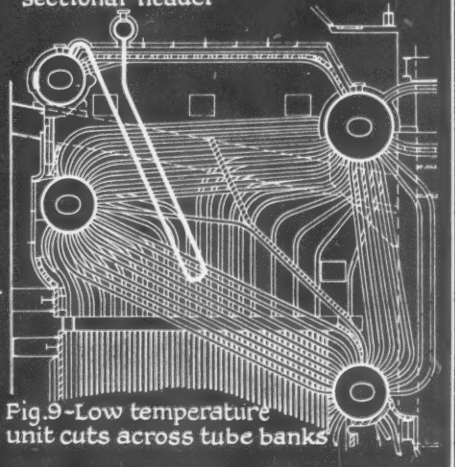


Fig.9 - Low temperature unit cuts across tube banks

WATER WALLS

ALTHOUGH first developed for stokers, water walls are now used in pulverized-coal fired, oil-fired and gas-fired furnaces. Their primary purpose is to permit higher rates of heat release without excessive furnace maintenance. This purpose they serve extremely well, greatly increasing boiler reliability. Although water walls materially decrease furnace temperature, they do not decrease exit flue-gas temperature to any greater extent than an equal surface in the main part of the boiler.

Water walls form an extremely active part of the boiler heating surface, often evaporating 100 lb. of steam per sq.ft. per hr. Because of the high rate at which the surface works, it must be amply supplied with relatively scale-free water, circulation must be rapid, and the tubes arranged so that none of them are starved. Tube burnouts and blisters will be sure to follow if any of these requirements are neglected.

There are no standards for tube spacing or arrangement, as may be seen from the illustrations on the facing page. Tube spacing is usually determined by the particular type of protective surfacing applied. Yet even when bare tubes are used, spacing may vary from $3\frac{1}{4}$-in. diam. tubes on $3\frac{1}{2}$-in. centers up to wide spacing such as in Fig. 5 depending upon how much water-wall surface is required. Either 3 or $3\frac{1}{4}$-in. tubes are used in water walls, depending on pressure. Larger diameter tubes are frequently used for water feed and circulators.

Water feed for the walls is taken from the mud-drum in the case of bent-tube boilers, or from the main drum in a horizontal straight-tube boiler, through a number of tubes rolled into the drum, usually the ends. Occasionally the downcomers are made to project into the mud drum, as in Fig. 2, to avoid danger of sediment being fed to the water wall. These feed headers are at the bottom of each wall. Sometimes for convenience, particularly in the case of straight tube-boilers, tubes from the drum are rolled into a stub header connected to a single large-diameter pipe feeding the bottom wall headers. Tubes, however, can be rolled into the bottom headers at regular intervals throughout their length, hence permit better distribution of feedwater.

Riser tubes rolled into the bottom headers form the water wall and are usually rolled into a top header, from which a smaller number of tubes deliver the steam and water mixture to the steam drum of the boiler. An exception to this is shown in Fig. 5, where the side-wall tubes are carried up individually into the steam drum. Another exception is shown in Figs. 2 and 6, where the rear wall riser tubes are rolled into the mud-drum. Sometimes these tubes are carried on through the mud-drum and connected to a row of boiler tubes, as in Fig. 6.

Water-wall tubes are usually bent and carried outside of the furnace before they are rolled into the top and bottom headers. Examples of this practice are shown in Figs. 1, 3, 6 and 7. In one type of wall, Fig. 2, the tubes are straight and rolled into the top or bottom of the headers which are inside the wall.

Fig. 3 illustrates a different type of wall arrangement in which the tubes are inclined instead of vertical. This arrangement is used particularly for stoker installations when only the wall near the stoker is to be protected. The tubes, inclined so they are parallel with the tuyeres, are rolled into headers at each end. The back or lower header is supplied with water from the boiler, and tubes rolled into the front header carry the steam and water mixture to the steam drum.

Some walls, as in Figs. 3 and 7, are provided with recirculator tubes connecting top- and bottom-wall headers outside the furnace. Since steam is not generated in these tubes, they cause water to circulate down through them and up in the water-wall tubes, thus creating a circulation. Their use makes it possible to decrease the number or area of tubes connecting the water wall with the steam and water spaces of the main boiler, as they have only to supply make-up water and carry off the steam and water mixture.

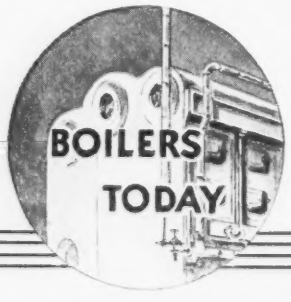
Providing openings through walls for access doors is something of a problem. In the case of large openings, stub headers are often used above and below the door, as in Fig. 2. If the door is small and tube spacing not too close, tubes may be bent so they go around the door.

Methods of Support

Considerable variation exists in the methods used to support the water walls. Several manufacturers support the top-wall header rigidly on steel anchored to building steel or boiler columns. The tubes, lower header and furnace bottom, if of the slag-tap type, all hang from the upper header, hence are free to expand downward. In some instances the top header is relieved of some of the weight by spring supports under the bottom header. Expansion in the tubes connecting the top header to the boiler drum is usually not great, because the tubes are relatively short. It is taken care of by flexibility designed in the tube connections.

Other designers support both top and bottom headers on springs such as are illustrated by Fig. 4. This permits downward movement of both top and bottom headers.

Sometimes, particularly with slag-tap furnaces, the bottom headers are anchored, and all expansion is upward. This arrangement prevents movement of the tubes through the furnace floor. The upper header is guided and/or supported on springs and moves vertically upward as the tubes in the wall expand.



TYPICAL WATER WALLS

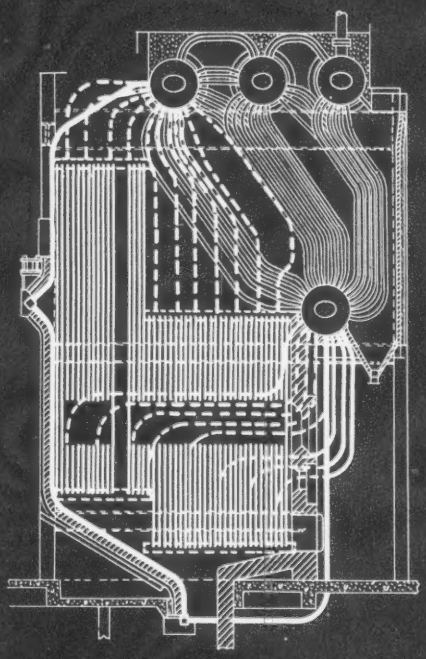


Fig.1(Left)-Water-wall with top and bottom headers

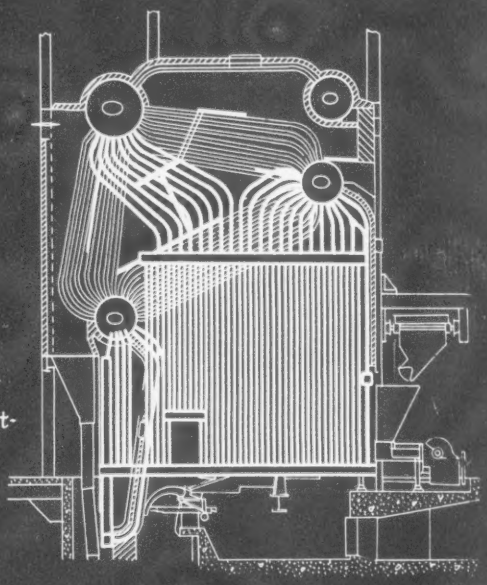


Fig.2(Right)-Water-wall headers carried in wall and down-comer tubes projecting into mud drum

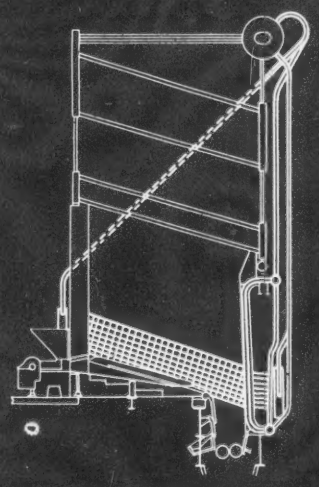


Fig.3-Inclined water wall used with stokers

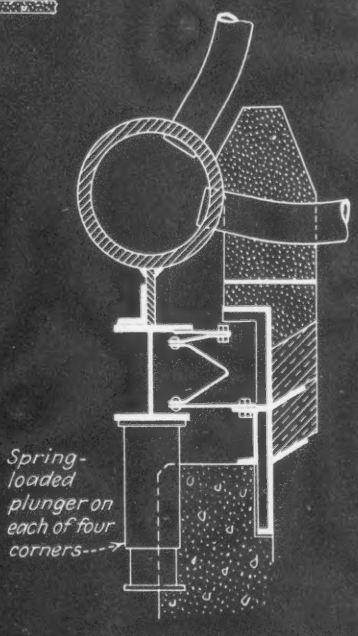


Fig.4 (Above)-Spring arrangement for supporting wall header

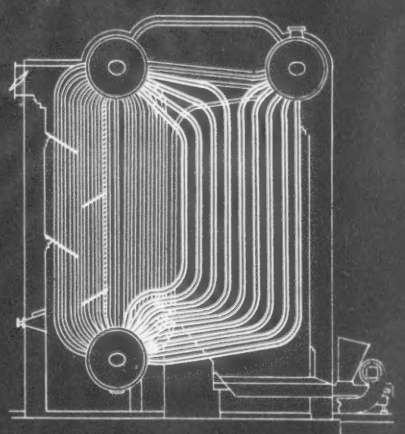


Fig.5-Side wall with tubes rolled into mud drum and steam drums

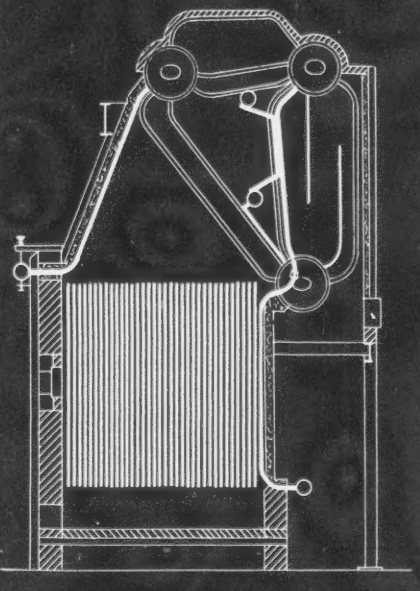


Fig.6(Left)- Water-wall tube carried through mud drum

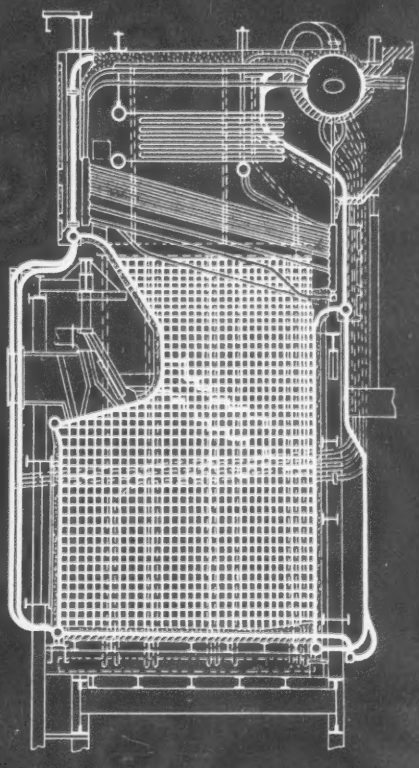
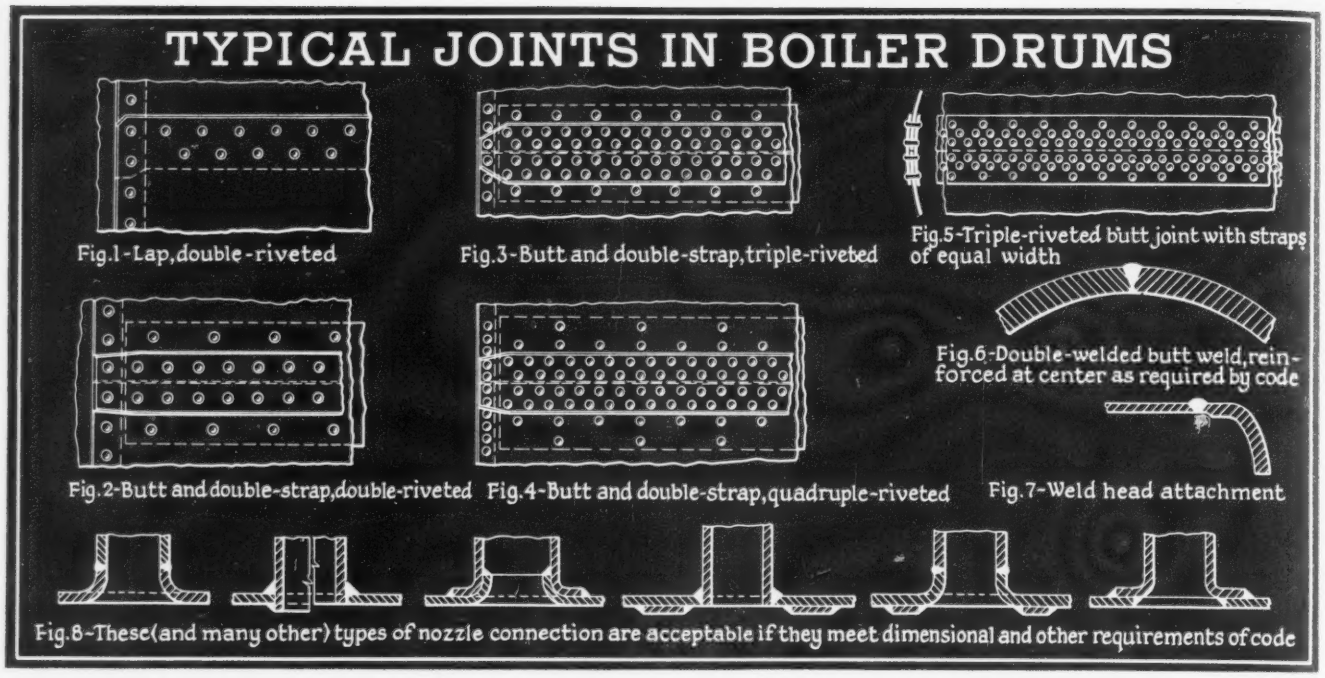


Fig.7(Right)-Water wall, showing re-circulation


TYPICAL JOINTS IN BOILER DRUMS
Fig.1-Lap, double-riveted
Fig.3-Butt and double-strap, triple-riveted
Fig.5-Triple-riveted butt joint with straps of equal width
Fig.6-Double-welded butt weld, reinforced at center as required by code
Fig.2-Butt and double-strap, double-riveted
Fig.4-Butt and double-strap, quadruple-riveted
Fig.7-Weld head attachment
Fig.8-These (and many other) types of nozzle connection are acceptable if they meet dimensional and other requirements of code

RIVETED AND WELDED JOINTS

COMPUTATION and fabrication of joints in boiler shells and drums is the manufacturer's problem. The user's knowledge of the matter need extend little beyond the point of ascertaining that the builder has a reputation for safe construction and operates under the safeguards of the A.S.M.E. Power Boiler Code. The two are generally synonymous.

The present comments on boiler joints, therefore, make no pretense of completeness. Data needed by the designer is omitted in these brief comments on riveted and welded joints. The Code, universally recognized "bible" of American boiler construction, will be used as the background for both illustration and comment.

Five typical examples of riveted joints are illustrated, building up step-by-step from the single-riveted lap (not shown) to the quadruple-riveted double-strap butt joint (Fig. 4).

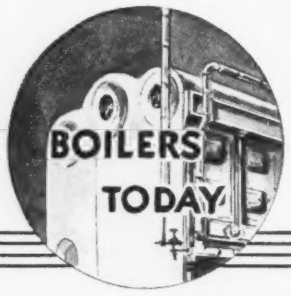
Single-riveted lap joints may be used for circumferential joints because these carry only half the stress (per lineal inch) of longitudinal joints. Lap joints in longitudinal seams produce dangerous eccentric stresses and "breathing" and are therefore prohibited by the Code for all shells over 36 in. in diameter, or operating at pressures above 100 lb. Even without this Code restriction, the single-riveted lap would generally be impracticable for longitudinal joints because its very low efficiency (under 60%), would require excessive plate thickness. It must be remembered that 50% efficiency in circumferential joints is equivalent to 100% in longitudinal.

It is a characteristic of all butt joints that the spacing of rivets is progressively greater as one works toward the outer rows. In a *properly* proportioned multiple-riveted butt joint, the efficiency approximately equals the percentage of solid plate remaining between rivet holes in the outer row of rivets. That is, if the holes remove 18% of the metal (measured along the center line) efficiency is approximately 82%.

Note that this rule of thumb is not a check on the correctness of the design; its application assumes correct design. In no case, however, can the correctly figured efficiency exceed the estimated.

Riveted joints for boiler shells and drums have two limitations. One is the fact that the whole shell must be thickened to compensate for their failure to reach 100% efficiency. The other is a tendency toward "caustic embrittlement" where boiler water is high in soluble carbonates (unless A.S.M.E. recommended sulphate-carbonate ratios are maintained).

Years ago these limitations were back of the demand that the Code legalize boiler welding. Fear of improper and dangerous welding delayed acceptance until 1931, when the Code formally approved "Class I" welding for boilers, surrounding the process with the most rigid safeguards. These include specification of type of joint, elaborate physical and chemical tests of the weld, X-ray photographing of all drum and shell seams and final stress-relieving by heating the entire drum or shell under specified conditions. Safety experience with thousands of welds so made has been highly satisfactory so that welded drums and shells are accepted by users without question.



BAFFLES

ALMOST with the first water-tube boiler came the baffle. Hot gas cannot be permitted to take the easiest way, but must be forced to follow a more-or-less tortuous path to make it "scrub off" its heat into the boiler tubes. About the only limit is excessive draft loss, hence excessive fan power and size, or excessive chimney height in the case of natural draft.

It is evident that if baffles force the gas to move in one direction across half a bank of tubes, and then in another direction across the other half, it will flow at higher velocity because of the reduced cross-sectional area. Higher velocity always produces higher heat transfer. However, it would not be good baffling, in the case just described, to break the tube banks into two equal parts. The first pass should have greater area to care for the larger volume of hotter gases. In general, baffling is designed to keep gas velocity nearly constant by reducing flow areas about in proportion to the shrinkage of the gas with lowering temperature.

Other aims of good baffling should be to avoid introduction of hard-to-clean dust pockets, and interference with operation of soot blowers or other tube-cleaning devices, and, as far as possible, to avoid interference with removal or replacement of boiler tubes.

Formerly baffles parallel to the tubes were most common in all types of boilers. This practice has largely been abandoned in horizontal, straight-tube boilers. In units of this type, cross-baffling increases the heat-transfer rate, without interfering with tube removal or replacement. Cross-baffling of horizontal water-tube boilers is also necessary where a superheater is installed in or above the tube bank. Moreover, positioning of the first baffle raises or lowers the superheat by decreasing or increasing the heating surface in the first boiler pass.

Bent-tube boilers are still often provided with longitudinal baffling for various reasons, one being that bent-tubes cannot be removed through the more common types of cross-baffles without destroying the baffles. However, the thermally more effective cross-baffling has recently been made practicable by a type of baffle construction which can be dismantled, where desired, without destruction. This is illustrated in Fig. 5.

In the majority of cases, in all types of boilers, reasons other than maximum convection heat transfer to boiler tubes determine baffle arrangement. These include ease of tube removal, control of furnace temperature, adjustment to superheater requirements. This is particularly true in units that include air heaters and economizer and generate steam at high pressure and temperature.

The effectiveness of the heating surface is greatly reduced by baffling that causes poor gas distribution or gas "pockets."

As in the case of superheaters, many illustrations of

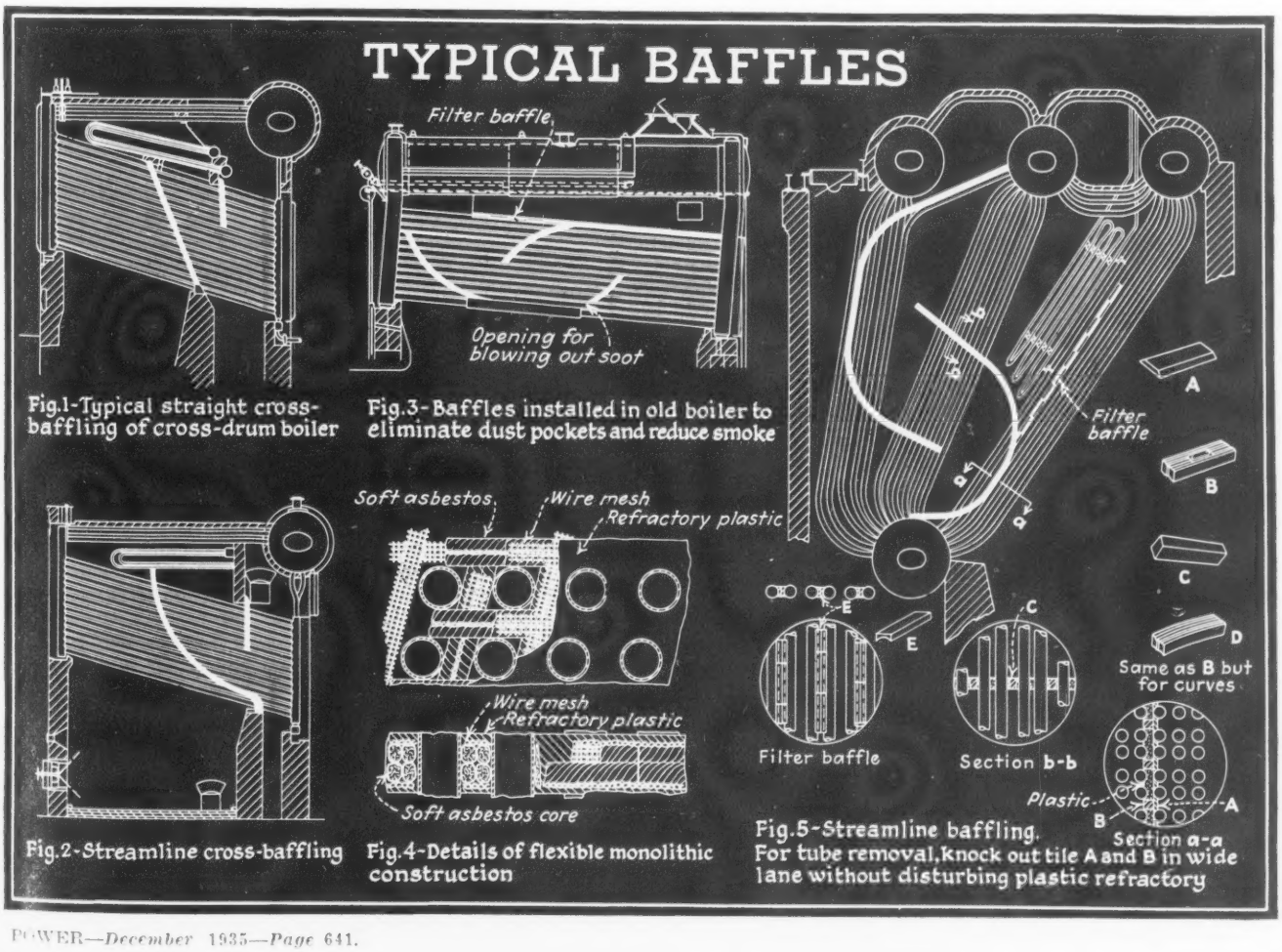


Fig.1-Typical straight cross-baffling of cross-drum boiler

Fig.3-Baffles installed in old boiler to eliminate dust pockets and reduce smoke

Fig.2-Streamline cross-baffling

Fig.4-Details of flexible monolithic construction

Fig.5-Streamline baffling. For tube removal, knock out tile A and B in wide lane without disturbing plastic refractory

baffle arrangements will be found in the boiler drawings on pages 626-628. A few additional forms are shown here.

In the cooler tail-end sections of boilers, baffles may be of very simple design and of unprotected steel. In the hotter portions close to the furnace, they must be of refractory material or of refractory-covered metal. The latter is satisfactory if temperatures are not too high and if the baffle metal is thoroughly "grounded" to the tubes so that heat is effectively removed.

Sometimes the baffles are built up of cast-iron T-plates fitted closely between the tubes, bolted at top and bottom to cast-iron crosspieces, and with both sides coated with a plastic cement that hardens under heat. Baffles exposed to very high temperatures are frequently made of interlocking tile.

It is quite common, particularly in industrial plants, to use baffles of monolithic construction, cast or rammed in place with the aid of a special form. Construction of such a baffle was described in the April, 1935, number of *Power*, page 198.

Considering the boiler by itself, the greatest efficiency of the heating surface is obtained by using a large number of passes. Thus, 3- and 4-drum bent tube boilers are generally baffled for either three or four passes. However, the single-pass boiler is sometimes used where it is very important to cut draft loss, either to reduce or eliminate mechanical draft, or to reduce the necessary chimney height. Positions of baffles may be varied so that the gas outlet of the boiler may be located in the rear wall, in the floor below the mud drum, or elsewhere as local requirements dictate.

Recent installations have shown a considerable saving in draft loss (up to 25%) by streamlined baffling, as illustrated in Figs. 2, 3 and 5.

Ordinarily a boiler is so baffled that the gases move in a vertical plane "fore and aft" of the boiler, but several of the modern self-contained steam generators depart sharply from this practice and baffle for gas flow wholly or partly in a horizontal plane. See Figs. 13, 15 and 16 on page 627.

STEAM CLEANERS AND DRYERS

DRY steam is one of the requisites of a good boiler even if equipped with a superheater. One of the early devices used to secure delivery of dry steam was the simple "dry pipe" still used in many boilers. It consists of a pipe of about the same diameter as the boiler outlet nozzle, placed close to the top of the drum. The top side of the pipe is perforated, and steam rising from the water in the drum makes a 180-deg. turn to enter the holes. As long as ratings are not too high, this keeps water entrained by the steam from entering the outlet nozzle. With higher ratings, more elaborate arrangements are often necessary, some of which are shown on the opposite page.

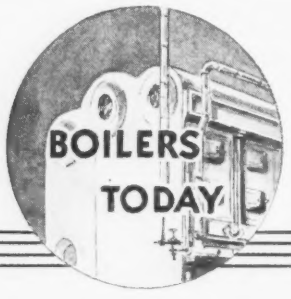
Figs. 1, 2 and 4 show the application of the "dry pipe" to straight- and bent-tube boilers. Baffle plates have been added to prevent steam and water from the circulators or risers spalshing or impinging against the dry pipe, and to help throw out water by forcing the steam to make an additional turn before entering the dry pipe.

In Fig. 3, the "dry pan" takes the place of the "dry pipe," and shutter baffles are introduced to help throw moisture out of the steam. Steam enters the space between the dry pan and the drum wall through perforations. The dry pan does not extend the full length of the drum, but extends over groups of tubes that supply the superheater.

Fig. 5 shows a method used to provide dry steam that employs neither "dry pipe" nor "dry pan." A vertical baffle extends from just above the steam circulators to the bottom of the drum. Steam discharged from the circulators is forced to travel to the ends of the drum at low velocity, where it flows around the ends of the vertical baffle to the main steam space.

The steam-drying arrangement used in the 2-drum boiler of Fig. 15, page 627, is shown by Fig. 8. Steam enters through slots on both sides of the "dry pan," flows lengthwise of the drum to the quiet end, and enters the space between the "dry pan" and the top of the drum through perforations in the "dry pan." Superheater inlet tubes are rolled into the drum at the turbulent end, forcing the steam to flow back to the opposite end of the drum.

High ratings and heavy concentrations in the boiler water both contribute to carryover of solids with the steam. These solids deposit on turbine blading in the low-pressure stages, decreasing efficiency and unit capacity. To prevent this, steam washers and dryers such as those shown in Figs. 6, 9 and 10 have been developed. Steam is first washed by entering feedwater which has a lower solid concentration than the water in the boiler and hence dilutes the concentration of solids in water entrained with the steam. The washed steam is then dried by corrugated plates or heavy screening before passing to the steam outlets. The washer of Fig. 9 dries the steam before it is washed. Steam washing is particularly necessary when the boiler water contains silica, as silica carryover is very difficult to remove from turbine blading. The sprays of Fig. 10 may be omitted when conditions do not require washing. Steam washers are said to reduce the solids in the delivered steam to 1 p.p.m. and moisture to $\frac{1}{4}$%.



DRY PIPES—STEAM WASHERS

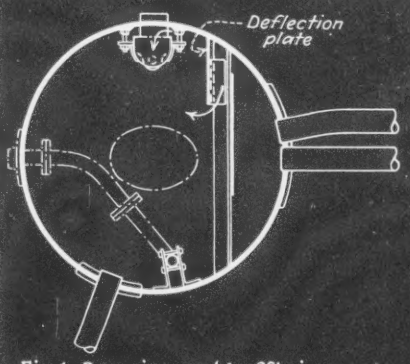


Fig.1-Dry pipe and baffle in a cross-drum boiler

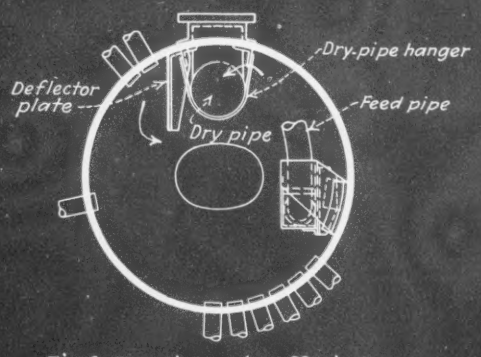


Fig.2-Dry pipe and baffle in bent-tube boilers

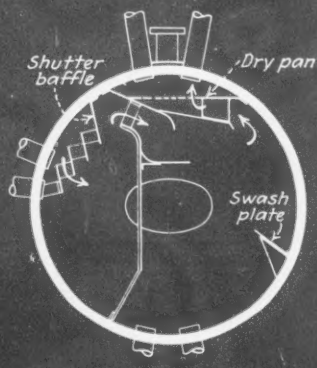


Fig.3-Shutter baffles and dry pan

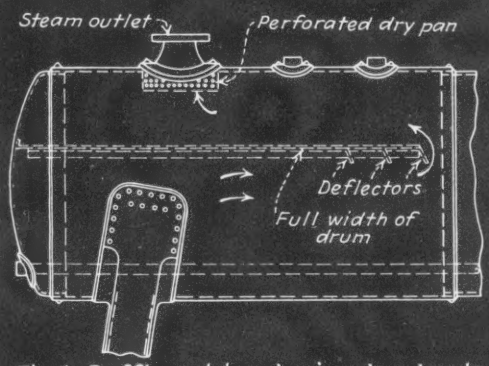


Fig.4-Baffle and dry pipe in a box-header longitudinal-drum boiler

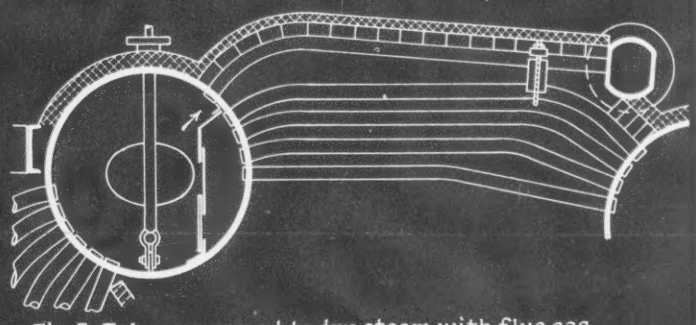


Fig.5-Tubes arranged to dry steam with flue gas

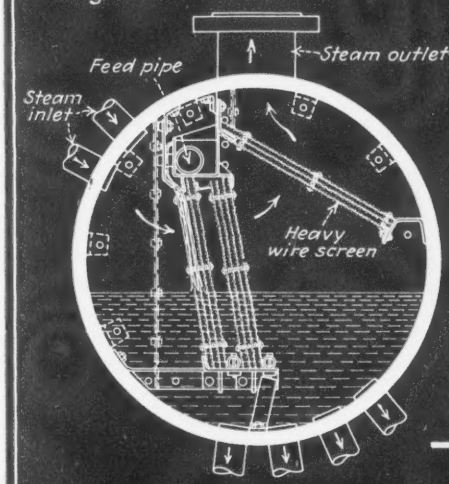


Fig.6-Steam washer with screen dryers

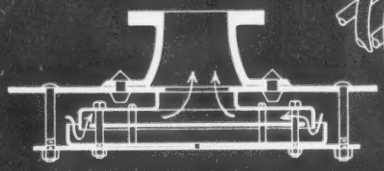


Fig.7-Internal separator

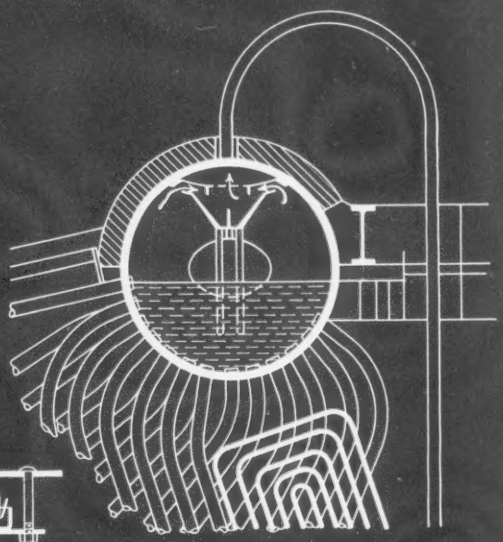


Fig.8-Dry-pan arrangement in a two-drum boiler

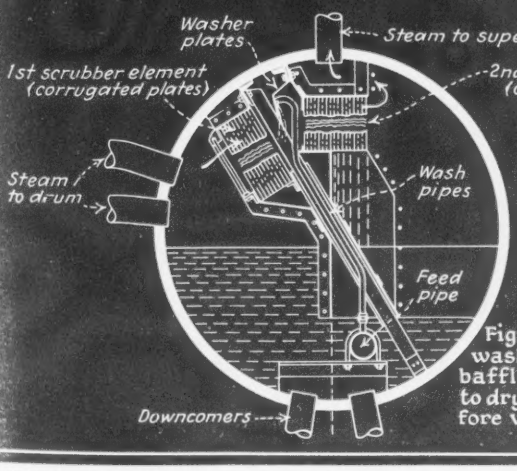


Fig.9-Steam washer with baffles arranged to dry steam before washing

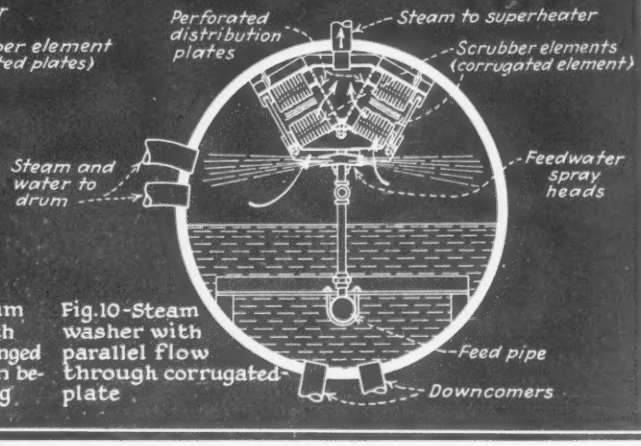


Fig.10-Steam washer with parallel flow through corrugated-plate

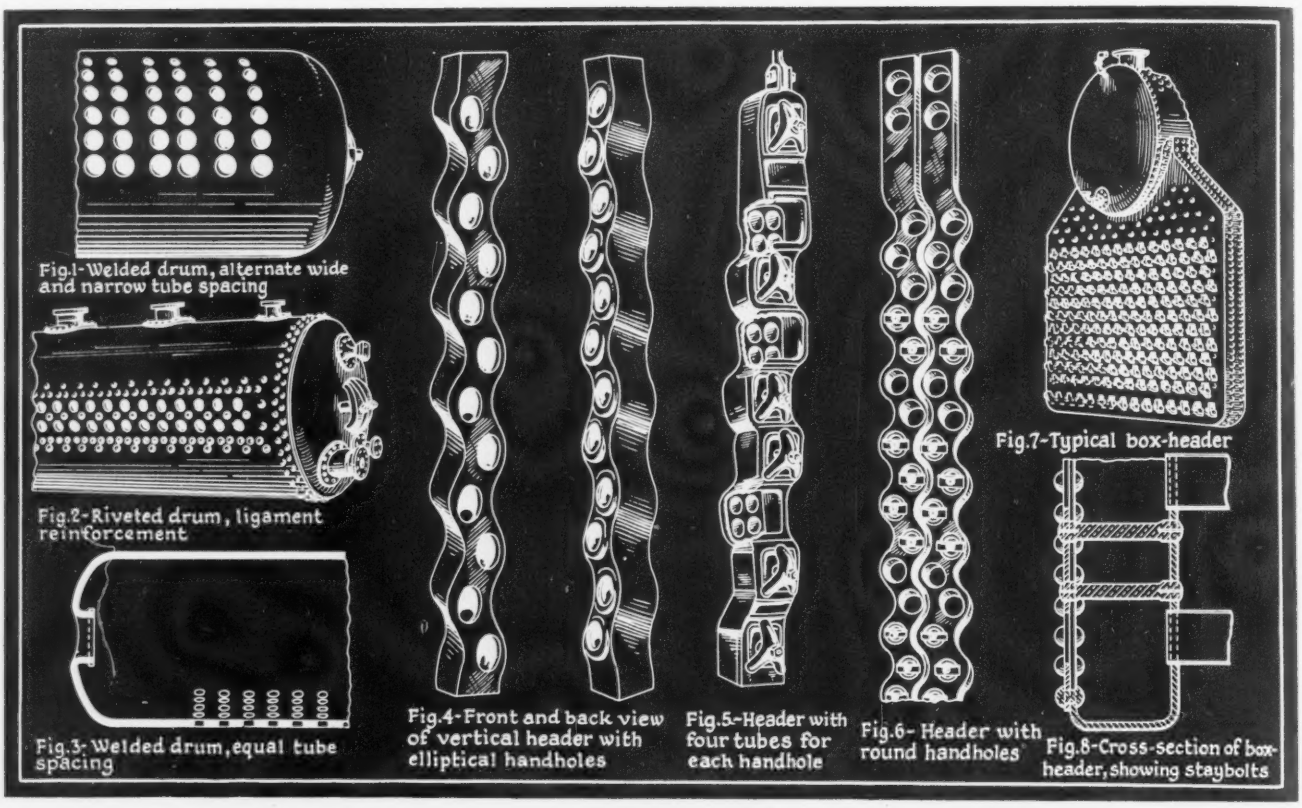


Fig.1-Welded drum, alternate wide and narrow tube spacing
Fig.2-Riveted drum, ligament reinforcement
Fig.3-Welded drum, equal tube spacing
Fig.4-Front and back view of vertical header with elliptical handholes
Fig.5-Header with four tubes for each handhole
Fig.6-Header with round handholes
Fig.7-Typical box-header
Fig.8-Cross-section of box-header, showing staybolts

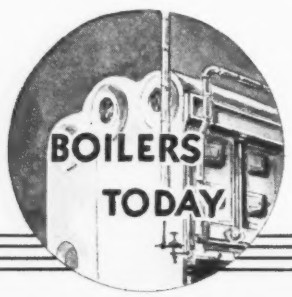
DRUMS and HEADERS

ONE of the most important developments in boiler construction came when 4 years ago the A.S.M.E. Boiler Code Committe approved rules permitting the use of fusion welding of pressure parts on power boilers. Before welding was permitted, boiler-drum joints and nozzle connections were riveted as shown in Fig. 2, except for very high pressures, for which drums were formed from a solid steel ingot and the ends forged down like the neck of a bottle, an extremely expensive process. Now the majority of drums are welded, as shown by Figs. 1 and 3, which incidentally also show two types of tube spacing used in bent-tube boilers. The alternate wide and narrow spacing is most frequently used, as it permits more tubes in a given length of drum while providing sufficient room for tube removal.

Welded drums are made of a single sheet rolled into cylindrical shape, with the edges welded together to form one longitudinal seam. Forged or spun heads are then welded to the cylinder. For higher pressures, and particularly in the case of bent-tube boilers, two sheets are welded together along two longitudinal seams to make the cylinder. This makes it possible to use a thinner plate for the wrapper sheet or top part of the drum where few tubes enter and ligament efficiency is high.

The A.S.M.E. Code requires that all main welded seams for pressures above 15 lb. be X-rayed. Up to the present, the thickest weld that has been X-rayed successfully is about $4\frac{1}{4}$ in. Gamma rays can be used for thicker metal, but the process is slow and expensive. Several manufacturers are now installing X-ray equipment that will penetrate $5\frac{1}{4}$ in. of metal. A recent high-pressure drum $5\frac{1}{4}$ in. thick was made by forging a cylinder from a solid ingot. Heads were welded on, the weld being limited to a thickness that could be X-rayed. This procedure is permissible as the metal at the ends of the drum need not be as thick as that part of the drum pierced with tube holes and also because a circumferential joint does not have to stand as much stress as a longitudinal joint.

Figs. 4, 5 and 6 show several forms of sinuous steel headers used on horizontal straight-tube boilers. Vertical headers require either eliptical handholes or large round holes in order that the tubes may be put in and rolled. In Figs. 4 and 6 each tube has one handhole, but in Fig. 5, one handholde serves four tubes. Tubes used with this header are usually 3 in. in diameter for medium pressures, while the other headers use 4-in. diameter tubes.



TIR JOHN

New British Station Burns Anthracite Duff

Top—Tir John, showing the 500-ft., 150-ton-per-hr. coal conveyor. Above—Feed pump driven by fan-cooled motor through hydraulic coupling

By David Brownlie

SWANSEA CORP. placed in operation June 20 the first 60,000-kw. section of the Tir John Station in South Wales, England. It is the second plant to be equipped for complete removal of acid sulphur compounds, as well as smoke and dust, from flue gas. Pulverized low-grade anthracite "duff" (dust and smalls) is being burnt, using air preheated to 700 deg. to insure complete combustion.

Steam is generated at 625 lb. pressure and superheated to 850 deg. by four 3-drum Combustion boilers. Each boiler has a heating surface of 13,230 sq.ft. and a water-cooled furnace of 16,900 cu.ft. which adds 2,600 sq.ft. of steam heating surface to the unit. Normal capacity of each boiler is 200,000 lb. an hour. They are capable of delivering a maximum of 240,000 lb. an hour, with feedwater entering an economizer at 350 deg. and air preheated to 700 deg. To obtain this high preheat temperature (the highest we have on record) two plate-type air preheaters were installed, one having 31,320 sq.ft., the other 39,690 sq.ft., with a fin-tube economizer of 6,870 sq.ft. placed between the two air heaters. The first heater raises air temperature to 430 deg., and the second to 700 deg.

Superheat temperature is controlled by by-passes around Melesco 6,300-sq.ft. superheaters.

It is well known that anthracite duff is one of the most difficult fuels to handle in a furnace. The duff used at Tir John is 74 to 80% fixed carbon, has 6 to 7% volatile matter, 14% ash, 4% moisture, and a heating value of 12,500 B.t.u. per lb. as fired. Melting point of the ash is 2,400 deg., and the only method of insuring complete combustion in pulverized condition at a sufficiently rapid rate is to use abnormally high preheated air in combination with an appreciable amount of refractory in the furnace.

Swansea is the center of the Welsh anthracite coal industry, consequently the duff is obtained very cheaply because it is almost a waste product. The furnace, therefore, is of special design because of the low combustibility of anthracite. The entire front wall, as well as a portion of each side wall, is of refractory, and forms an incandescent ignition zone underneath the burner. Detrick suspended air-cooled walls are used, and secondary air is introduced into the furnace through hollow tile in these walls. Dampers are arranged so that the air admitted through these walls may be controlled separately for each wall. There is also a secondary air inlet through the rear wall. The

rear wall and the rest of the two side walls are cooled with fin-tube water walls and the furnace bottom is protected with a water screen.

Unprepared anthracite duff is stored in two 700-ton stokers from which coal is fed to one slow-speed ball mill per boiler. The mills are 72 in. in diameter and 10 ft. long, with a capacity to pulverize 10 tons of anthracite duff per hour to 85% through a 200-mesh screen. The mills are driven by a 400-hp. motor through helical gears at 250 to 290 r.p.m. One 100-ton capacity pulverized-coal bunker is provided for each boiler. Coal from these bunkers is fed through six feeders to twelve Lupulco fan-tail burners arranged in line over the front of the furnace for each boiler. These burners fire vertically through suspended arches.

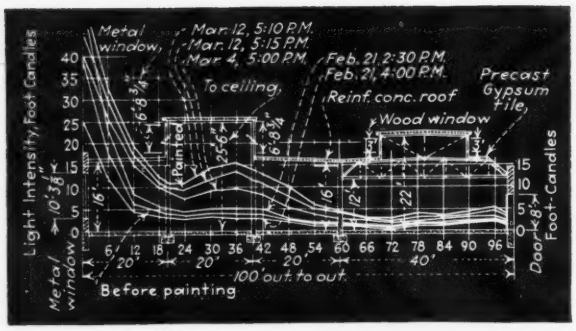
Secondary air for each boiler is delivered through air preheater and air-cooled walls by the two forced-draft fans, driven by variable-speed motors. One induced-draft fan, vane controlled, delivers the flue gas to steel stacks 80 ft. high and 20 ft. in diameter.

Four Weir feed pumps take their suction from four booster pumps. The feed pumps receive water at 358 deg. and 250 lb. pressure and discharge at 800 lb. They are motor-driven through hydraulic couplings.

The plant for removing acid sulphur compound from the flue gas is essentially similar to the installation at Battersea and uses a lime cream with an especially designed scrubber plant. It is claimed the equipment removes 96% of the dust, 96% of the total sulphur, in addition to 95% of the sulphur acid, and 60-90% of the nitric acid found in small amounts in combustion gas.

Precipitated sludge which is largely calcium sulphite, together with the ash from the plant, is discharged directly to the Crymlin peat bog that adjoins the station, and it is unnecessary to use filter presses for the sludge such as are being installed at the new Fulham Power Station, London.

First section of this station contains two 30,000-kw. Parsons reaction turbines designed for the most economical load at 24,000-kw. Vickers-Armstrong condensers designed to produce a vacuum of 29 in. are provided with four sets of Weir "Maxivac" air ejectors, as well as six sets of "Weir" steam-jet exhausters.



White Paint and Light

AMERICAN STOVE CO., Lorain, Ohio, has recently made some studies on the relation of paint to light which are of interest to power-plant operators.

Before the building was rehabilitated, readings were taken with a Sight-meter to determine what light conditions were. The results are plotted in the lower series of curves. Then the interior was repainted with white paint, and the readings taken again, these giving the upper set of curves. Readings in each case were taken at 6-ft. intervals across the building, on days when light conditions were comparable out of doors. The paint job was a single coat over a very dirty surface; these levels would have been raised considerably with a second coat. For example, light on the working plane at 5 P.M. Mar. 4 (after painting), is 100% better than it was at 4 P.M. Feb. 21 (before painting). At 5:10 P.M., Mar. 12, working light was 15 foot-candles in the monitor bay after painting, as compared with 5 foot-candles before. In the 40-ft. bay, painting more than doubled working light.

A survey of this sort is significant in that it demonstrates how reflection values of paint may be used to provide a greater and more even distribution of light, whether from artificial or natural sources. Reflection values of the various colors are: white, 84-89%; cream, 77%; buff, 63%; light green, 52%; gray, 46%; brown, 16%, and black, only 2%. These figures are from Sherwin-Williams Co.

BUZZARD POINT USES PHOTO

Industrial applications of photo cells have been many and varied, but their use in steam plants is relatively new. Here are two ways to use them

IN OPERATION of pulverized-fuel fired boilers, particularly at very low ratings, it is important that the operator know instantly when ignition fails. Loss of ignition occurs for two reasons: First, because the low furnace temperature and the lean coal-air mixture does not support combustion as well as at normal operation. Second, because irregularities of coal feed and load sometimes reduce the quantity of coal below that necessary to maintain ignition under any conditions. Normally, unless one operator can devote his entire time to watching the fire, it is unwise to operate the boilers under such load conditions.

To guard automatically against this condition at Buzzard Point plant, each pulverized-fuel fired boiler is equipped with a photo-electric cell, so arranged that its source of illumination is from the furnace fire. If the fire goes out, the cell operates to sound an alarm. In this way the operator is immediately notified. He can then either cut in the gas lighters to relight the

coal or cut off the coal feeders if the pressure is too high to warrant immediate re-ignition. Thus, unburned pulverized coal is prevented from being blown into the boiler setting.

The mechanical arrangement of this cell is very simple, as indicated in the lower figure. The photo-electric cell is supported to "look" through an observation door across the front of the boiler about 3 ft. in front of the burners. The cell is connected by a flexible cord to the relay unit which contains the closing contact in the alarm circuit.

Unless circulating water intake screens are kept in continuous operation, clogging constitutes an ever-present hazard, particularly when the screens are unattended by an operator. In most installations these screens are at a considerable distance from the plant, so that their proper supervision is expensive or difficult. Most screens are not designed for continuous operation, and lubrication is always difficult.

To obviate the necessity of having an attendant at the screens, and the possibility of an emergency shutdown due to circulating-water failure, the arrangement below was devised. A float in the water on the inlet side of the revolving screens moves a photo-electric cell. Water level on the discharge side moves a 110-volt lamp attached to another float. As the tide changes, the light source and photo-electric cell move up and down on their guide rods with no change in their relative positions.

By
C. E. Miller
Test Engineer,
Potomac Electric Power Co.

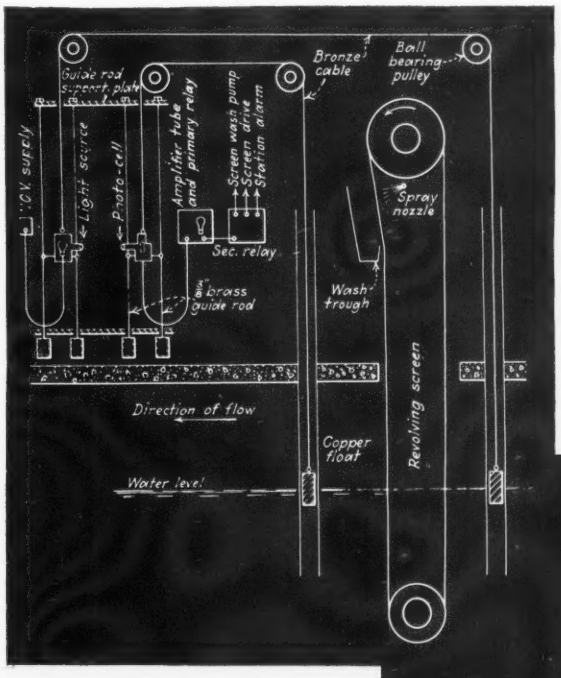
CELLS

If a school of fish or excessive debris such as grass or seaweed starts to clog the screens, the water level on the discharge side will drop and raise the light beam off the photo cell. This causes the auxiliary relay to operate a second relay. The latter has three closing contacts which simultaneously start the revolving screen motor, screen-wash pump, and sound an alarm in the station. The operator will be notified when the screens start and will visit them when his other duties permit.

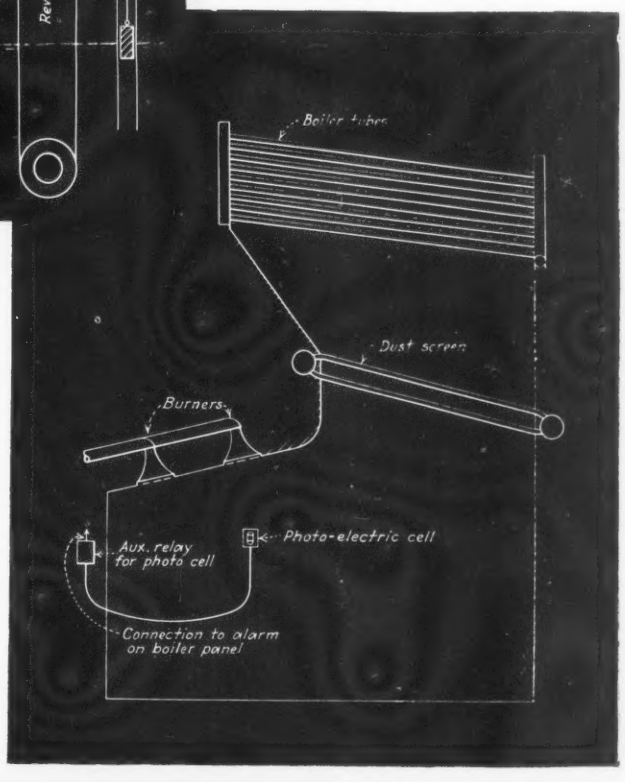
Copper floats and bronze wire are used to retard corrosion. The pulleys, of large diameter, are equipped with ball bearings to minimize friction. The light and cell slide up and down between $\frac{3}{8}$-in. brass rods as guides. To keep these rods vertical under variations in temperature, they are supported at the top only. A weight hangs on each rod under the bottom guide plate.

Present practice is to have the photo-electric cell operate when the water level on the discharge side drops 4-in. below the intake. This does not cause the screens to operate excessively and at the same time keeps them from becoming clogged and over-straining them, shearing pins in the screen drive, or possibly entirely shutting off the circulating-water supply.

EASIER THAN PIE—When you get the area of a circle, you probably square the diameter and multiply by π, which is 3.1416, and then divide by 4. Well, don't do it. That's all right if you're studying geometry, but it's much easier to take the diameter, square it, and multiply by 0.7854. That's the relationship between the area of a square and that of a circle inscribed in it. For instance, you have a 9-in. compressor piston out. All right, 9x9 is 81, and 81x0.7854 is 62.174 sq.in. piston area. Or if you're just estimating, use 0.78 and get 64 sq.in.



Left — Photo-electric cell prevents failure of condenser circulating wate.



Below — Photo-electric cell gives warning of pulverized-coal ignition failure

TO START WITH COOL,

By A. G. Solomon
Washington, D. C.

AS A RULE, starting up the drinking-water system (including refrigeration) in a new building is a mean job. Most of the trouble is caused by dirt left in or allowed to get into, pipe work, condensers, evaporating coils and in other pieces of equipment.

Let us go through and discuss all parts of the job as it proceeds: The first place to clean is the pipe itself. When it is unloaded on the job, try if possible to set the lengths on end and give each a few blows with a hammer to jar loose any dirt that may be inside. When pipe is taken from the storeroom out to the job, cover the ends with cloth or stuff them with swabs to keep more dirt from getting in. As shorter sections of pipe are threaded, a small piece of cloth or paper might be pushed through them with a small-diameter bar or pipe. It is probably more practical to blow the lengths clean with compressed air or flush them out with water.

Many times, fittings contain dirt, particularly return bends. Do not neglect looking for dirt of some kind in all valves and fittings. Automatic valves and devices usually come carefully packed and should be free of dirt, but don't take a chance. After the plant is started, also, any dirt that is in the system seems to gravitate toward the automatic devices to cause trouble.

All threaded pipe joints are made up with some kind of dope. Plain oil, graphite and oil mixed, white or red lead, prepared pipe-thread dope, and litharge and glycerine are commonly used to make tight screwed joints. Clean threads on both pipe and fittings to remove any dirt or rust or old oil. For ammonia, Freon and CO_2 threaded work it is proper to wash all threads with gasoline and then wipe them dry with a clean cloth (Most systems are now welded or flanged). Do not use waste or greasy rags. Litharge and glycerine will not take hold where there is grease or oil.

Next examine threads for defects and try the fitting on the pipe to see how far it makes up by hand. When you dope the threads do not put any dope on threads in the fittings, but dope threads on the pipe carefully so that all parts are covered. Any dope put in the fitting will be pushed ahead of the pipe end and simply means more dirt going into the system.

Litharge and glycerine are usually used in making up screw joints for ammonia, Freon and CO_2. This combination will harden like cement, and any that is inside the fitting will find its way into other apparatus with small openings. Pieces of hardened litharge can easily block a $\frac{1}{4}$-in. gage line or the opening of an expansion valve. Of course there are usually screens in various parts of the system, but often hardened particles of pipe dope do their obstructing before they ever get near a screen.

Often, too, in operations, engineers take out the screens and leave them out because they are too difficult to clean, assuming that after the first month or so of operation all dirt has been caught in the screens and they are no longer needed.

Next comes testing for leaks and locating and repairing them. Subject the part of the system containing the refrigerant to a high-pressure air test and locate leaks by sound if they are large and by smell or soapsuds if they are small. Oil of peppermint is used in CO_2 systems. The amount of pressure required for testing depends on what refrigerant is used, as this determines the operating pressures to be carried.

After all leaks and defects have been repaired, the entire refrigerating system must be blown out well to remove any dirt that might still remain. Do not, of course, leave screens or automatic valve devices connected in place during high-pressure testing and blowing out. Remove the screens from their chambers and use a short piece of pipe in place of automatic devices. This prevents damage to delicate parts. Blow everything at least four times and with as high an air pressure as permissible. In some installations drain valves, if provided, will not be proper openings for effective blowing out of all dirt. Look over the system and make the needed openings by disconnecting flanges at points where the most dirt will collect.

After testing and blowing, connect up automatic devices and put screens in place. Test this small amount of pipe work while the vacuum is being pumped on the system. This vacuum is necessary to remove all air, and it is good practice to hold it at least 20 in. for 8 to 12 hr. or longer. Even small leaks will show up by loss of vacuum. Leaks can be found by sound or by candle flame tests of suspected places, the candle flame being drawn toward the leak.

Now we are ready to charge the refrigerant into the system. As soon as pressure goes above atmospheric, begin watching and listening and smelling for leaks, and repair any leaks no matter how small as soon as found. It is best to operate the system by manual control for the first few days. After the engineer is satisfied that all equipment is in proper operating condition, automatic valves and other devices can be set to take care of desired temperatures and pressures.

The same general care must be taken in erection of water lines as was taken with refrigerant pipe work.

Of course leaks are not so dangerous as those in refrigerant lines, but they nevertheless cause trouble and cost money. Instead of litharge and glycerine, some prepared pipe-thread dope or red or white lead is used in making up screwed joints. Again use the dope on the pipe threads only.

Small particles of any substance left or put in the pipe will surely find its way into the small openings of drinking fountains and cause trouble, ranging from leaking valves to inability to keep the water at the proper temperature. All drinking water fountain valves must be in a condition to open easily and close tightly. The float control valve that admits the proper amount of fresh water to the system must also be working freely and closing tightly. If it sticks it will allow the system to empty either entirely or partly, thus making it impossible for the refrigerating equipment to provide water at proper temperature.

There should also be a gate valve in the water line ahead of the float valve, and water should be controlled by hand during the first few days the new plant operates. Several times each day the gate valve should be opened wide to allow any dirt to be flushed out of the lines. During this hand regulation, the float valve can be removed or tied wide open. When the float valve is put in operation be sure to set the float so that all ammonia evaporating coils are covered with water. Still, water level must be low enough to prevent loss of water at the overflow.

While the drinking-water system is being installed there is always danger of bits of wood, shavings, paper, cork and other kinds of dirt getting into all parts of the system. Before turning on the water, remove as much of this dirt as possible, as described before.

When the water is first turned into the lines supplying the drinking fountains, block the last fountain on the line wide open, and have all others closed. This will tend to drive any dirt to the end where it can be easily removed, or the return water line can be disconnected and all fountain lines flushed through this opening. If there are any screens in the water lines or at the circulating pumps, clean them daily for the first weeks of operation.

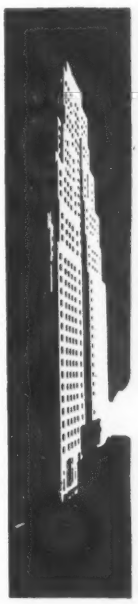
Dirt can interfere with continuous and efficient operation also at the regulating valve that controls the flow of water through the condenser (if one is used). This valve is set to allow sufficient water to circulate through the condenser to maintain the desired condenser pressure and to open and close when the machine is started or stopped. Small particles of dirt will cause sticking and may cut down the flow of water or result in waste and added water cost. This automatic water-regulating valve is one of the most important valves in the plant and must be watched closely.

There are also a few general points to watch. One is the screen in the ammonia suction line close to the compressor. This screen must be cleaned several times during the first months of operation. Also if there is a screen at any point in the main liquid line, it must receive the same attention. Next are the fine-mesh screens that are part of the automatic expansion valves and other automatic devices that control the flow of the refrigerants. These screens should be cleaned at the end of the first 12 hours and then should be cleaned once each week for four weeks. After that they need not be looked at unless there is indication that the flow of refrigerant has been reduced. Low suction pressure or increased superheat of suction vapor are the first warnings of partially blocked screens at any point between condenser and evaporator.

All systems should have valves at both sides of all automatic devices and also by-pass lines so the automatic device can be removed for repairs without having to pump a vacuum on the system and then fill it with air that must be pumped out again. Lowering pressure below atmospheric should be avoided as far as possible. If any air is allowed to enter the system be sure to remove it by pumping out and then by purging.

There should also be connections including hand-regulated expansion valves so the plant can continue to operate in case an automatic expansion valve requires repair. Sometimes better results can be obtained by regulating the flow of refrigerant by hand instead of depending on automatic control, and it is not good practice to change the setting of automatic devices frequently to meet short periods of changed operating conditions. Hand regulation can be used during such periods.

One final caution has to do with something that all engineers should know, but which nevertheless causes trouble. It is simply that dirt can also get into bearings or even in the crankcase of the compressor during the erection of the plant. Before starting the plant be sure to look into the crankcase and into all bearings, and if necessary, wash bearings with gasoline. Change the oil in all bearings and in crankcase after the plant has operated not more than two weeks. The oil that is drawn out can be filtered and used again. Most compressors have both splash and force systems of lubrication. There is a screen in either the suction or discharge of the oil pump which must not be neglected.



CLEAN, DRINKING WATER

How to avoid trouble with water and refrigeration systems in new buildings

DIESELS DRILL FOR OIL

Diesel-electric and semi-diesel-electric portable plants provide d.c. drilling rigs with power, anywhere, anytime

By W. C. Lane
Tulsa, Okla.

DRILLING for oil is transitory work. Under modern methods it is not unusual to see a 6,000-ft. well completed in 30 to 60 days. Oil fields have a habit of appearing far from improved highways. Roads are frequently bad—in many places the term "road" is only a name applied to a passage slashed through the scrub to a sandy trail across the desert or to deep ruts winding through the swamp grass. Drilling equipment must be moved over the most difficult terrain. When apparatus arrives in a field, it must often be set up at the least accessible point.

The first oil wells to be drilled electrically were powered by slip-ring a.c. motors driving cable or percussion tools. Later, motors were applied to apparatus used in rotary drilling. Energy was procured from power lines brought for pumping oil from old wells.

The major problem involved is that of heavy, rapid, accurate hoisting. It has long been obvious that d.c. motors are more adaptable to the work. However, line losses incident to transmitting d.c. energy over anything more than a nominal distance condemn the method commercially.

Light Diesels Come In

Within the last two or three years, manufacturers have developed light, comparatively high-speed internal-combustion engines of sufficient capacity and reliability for use with portable generating plants. They are being used to drive both d.c. and a.c. generators and are giving splendid satisfaction. D.C. energy and the Ward-Leonard system of speed control are attracting much favorable comment. The so-called "shovel-type generator" has been found to have ideal characteristics, and while the application is new, little new electrical equipment is involved.

Eighteen rotary rigs have been electrified with d.c., most of them in the Mid-Continent area. Operators are very enthusiastic about their behavior.

Three major operations are involved in a rotary rig —rotating the drill bit, pumping slush and handling pipe. The first requires from 25 to 125 hp., the second from 75 to 250 or 300, and the last the entire capacity of the plant. It is necessary to vary motor speed to perform all three to best advantage. In applying the Ward-Leonard system, a minimum of two main generators and one exciter is necessary.

Under normal conditions, one generator drives the drilling and hoisting motor and the other the slush-pump motor. When drilling is suspended (as when it is necessary to replace a dull bit), it is necessary to withdraw the drill stem from the hole, break it up into about 90-ft. sections and set them in the rig before the bit can be reached. The pipe is then returned to the hole and drilling work resumed. Since the only profit-producing time is that devoted to cutting a hole, it is obvious that time spent in changing the bit should be a minimum. For this reason when it is necessary to "make a trip with the pipe," the entire capacity of the plant is devoted to hoisting.

Plant Makeup

Plants now in operation are made up of two, three, or four main generators and one or two exciters. The two-generator plants are arranged for either series or parallel operation, the three for parallel operation and the four for operating the generators in series of twos. In the case of the latter, only two of the four are used for hoisting. Some existing plants are driven by one engine, others by two, still others by three.

One type of plant consists of two identical engine-generator units so arranged that in case of emergency the generators may be coupled together and driven from either engine. Each unit includes a 200-kw., 200/250-volt, 1,200-r.p.m. main generator and a direct-connected 20-kw., 125-volt, compound exciter. Main and auxiliary generator are driven by a 9 x 12-in., 8-cylinder., 600-r.p.m., 350-hp. full-diesel through a clutch and V-belt drive. Though the two generator-exciter units are on a common structural-steel base and a flexible coupling is always in place, ordinarily the coupling is disconnected.

The drilling and hoisting motor is rated at 200 hp., 220 volts, 450 r.p.m. 40 deg., when operated from one generator and at 400 hp., 900 r.p.m. when operated from the two generators in series. It is of the separately excited shunt type and is totally enclosed as a protection against fire and explosion. Air for cooling the motor is supplied by a motor-driven blower on the motor frame. This makes ventilation independent of speed so that in hoisting the motor is able to stand still and hold a load without injury. The slush-pump motor is identical, but under normal conditions its field is so adjusted that it will run at 900 r.p.m. when the voltage of one generator is impressed on it.

While drilling, the mains of one main generator are connected directly to the armature of the drilling motor and those from the other are connected to the slush-pump motor. Fields of both generators and those of the motors are energized from the mains of the 20-kw. exciter. This makes it possible to keep the motor fields constant and to vary the speed of each by alternating the voltage of its driving generator. When the drill stem is to be withdrawn, the pump is stopped and the generators connected in series.

As a protection for the generators against an overload and to prevent stalling the engines, the generators are equipped with differential series field windings.

These are so adjusted that load is always within plant capacity. Energy for operating the blowers on the motors, for pumping cooling water, lighting the rig, and operating a wash-down pump is supplied by the 20-kw. exciter.

Hoisting work on a rig is especially exacting and is somewhat hazardous for every member of the crew. The motor is started, stopped and reversed by manipulating a handwheel which actuates a small reversing generator-field rheostat. During this operation the clutches may be left engaged, and since a motor can be made to hold a load while standing still, less use need be made of the brakes. Concentric handwheels are used for operating the two rheostats and when hoisting work is in progress the two wheels are interlocked and both generators are operated as one.

Another plant in use consists of a 240-kw. and a 150-kw., 350-volt, 1,200-r.p.m. generator and a 20-kw., 125-volt exciter all coupled together and belted to three 9 x 10½-in., 6-cyl. 200-hp., 514-r.p.m. full diesels. When two generators having different capacities are connected in series, the combined capacity is equal to only twice that of the smaller. For this reason generators in this plant are arranged for parallel operation. The differential fields provided not only limit the load as described above, but also make it easy to parallel the generators.

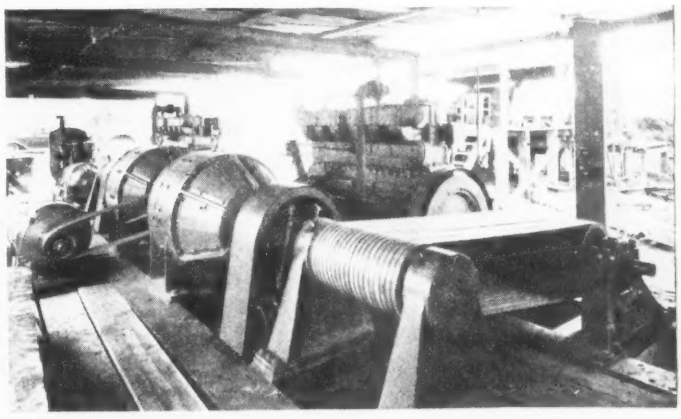
Motors are identical and differ from the ones on the first rig described in that they have both a shunt and a series field. The series field is not used on the drilling motor, but is connected in the circuit on the pump motor. The series field gives the motor a drooping speed characteristic, which is said to protect the pump from abnormal pressures in case of a plugged bit. The virtue of this is questionable when one considers the amount of inertia in the drive and in the mud stream. The motors are normally rated at 275 hp., 350 volts, 1,000 r.p.m., and at 400 hp. for intermittent hoisting work.

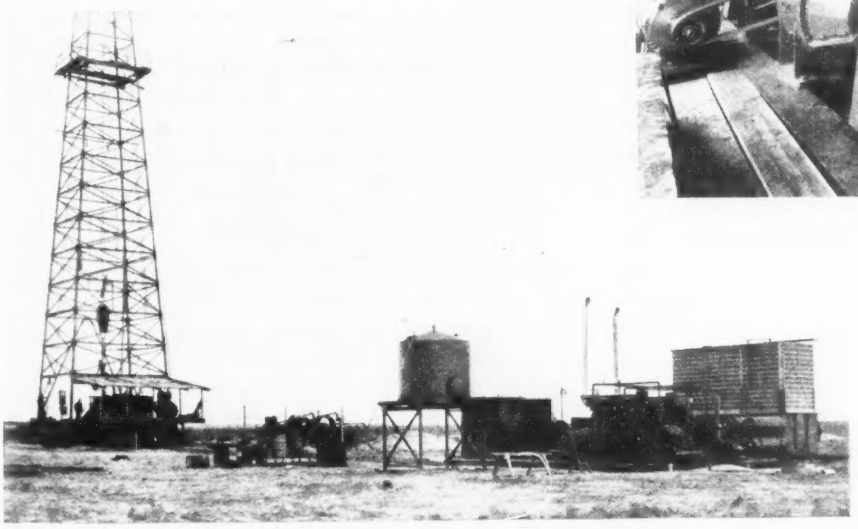
Capacities of two generators can be utilized more effectively when they are unequal by reason of the unequal power demand of the two motors during drilling. Demand for the pump may be 250 hp., while that of the drilling motor usually does not exceed 100 hp. When generators of equal capacity are used, one will always be lightly loaded and the other may be overloaded. On the other hand, since the torque of a motor having full Ward-Leonard control is directly proportional to the current, it will exert as great a torque when driven from one generator of a series system as from two. In case one unit is down and hoisting work is to be done, the same load can be lifted with one generator as with two, but of course at half the speed. In operating from only one generator of a parallel system, the motor tends to run at the same speed that it does when operated from two generators, but the current capacity is less. In order to utilize the power it must be possible to change the speed reduction of the draw works an additional ratio of 2 to 1. When this provision is made it may be said that there is little advantage of series over parallel operation for hoisting work.

Three chief factors to be considered by a contractor drilling for profit are transportation, fuel, and water. A heavy steam rig uses from 1,200 to 2,000 barrels of water per day, 75 to 80% evaporated by the boilers, and the remainder is used in the slush pits. The latter may be any kind of brackish, muddy, surface water, but the former should be good water or the boilers will suffer. The only good water used by the diesel-driven plants described above is about one barrel per day to replace leakage from the engine cooling system. Something like 500 barrels of pond water per day is ample for the pits.

Fuel burned in a diesel rig amounts to 6 to 10 barrels of diesel oil per day, as compared with 80 to 120 barrels of fuel oil for three 1,000-sq.ft. boilers and a materially greater consumption when three 1,250-sq.ft., 350-lb. boilers are used. In the Oklahoma City oil field, the lighter steam rigs burn 500,000 cu.ft. of gas per day, while some heavier rigs use as much as 1,500,000 cu.ft. Consumption of one d.c. rig with gas engines was 87,600 cu.ft. of gas per day.

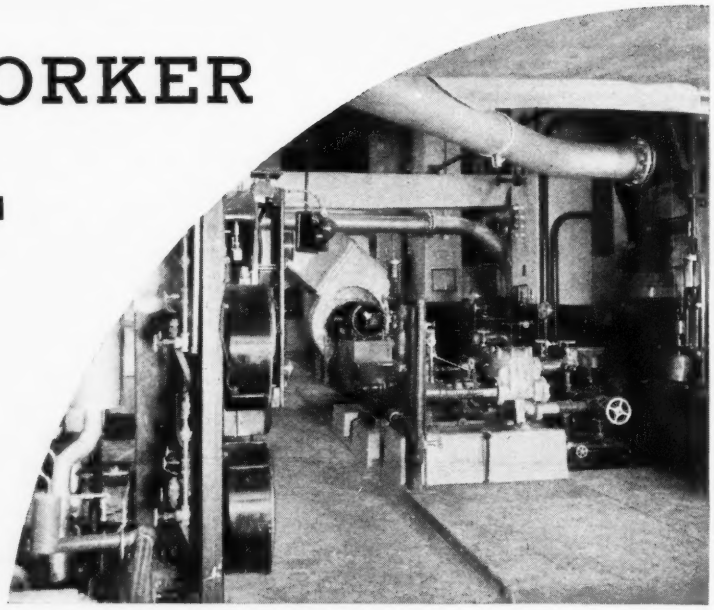
It appears that diesel-electric rigs have come to the oil country to stay. They are especially adapted to wildcat work remote from power and gas lines where good water is likely to be scarce. Data now accumulating indicates that diesel-electric rigs can be used competitively under practically any working condition.





Above—Two spark-ignition oil engines driving coupled d.c. generators and one exciter. A separate exciter is driven by a third engine. Left—Diesel-d.c. plant on the desert, using 6-cyl., 9x12-in., 600-r.p.m. diesels

HOTEL NEW YORKER SHIFTS TO OIL



Change-over saves over half its cost in first year, gives fuel-bargaining power, added fuel reserve, raises CO_2 to 15%, permits rapid changes

WHEN the Hotel New Yorker power plant was put in operation in the fall of 1929, burning pulverized coal was hailed as an innovation for hotel service. Designers' expectations were presented in *Power* (Nov. 26, 1929, page 836), and the excellent results obtained are shown in plant records. Substitution of oil for coal was considered from time to time, but not until 1933 was it financially desirable. Then a contract was signed with Petroleum Heat & Power Company for the necessary fuel and oil-burning equipment.

In changing to oil, I insisted on two design requirements: (1) We must be able to burn oil or pulverized coal equally well. (2) Forced draft must be used with either fuel. These requirements were based on these facts: Installed pulverizer equipment was in first-class condition, a 2-fuel installation is desirable in an isolated power plant, and it permits fuel selection according to the market.

Space in the New Yorker is at a premium, so the only place for the fuel-oil storage tanks was in the ash cellar in front of the boilers. Here, by taking advantage of all available space and relocating considerable equipment, two 8-ft. diam. tanks were installed, one with 12,000 gal. capacity, the other with 14,000. Both tanks were built in concrete enclosures, the concrete tops replacing the original grating floor of the boiler room.

Advantages of forced draft in burning pulverized fuel are conceded, so why natural draft was originally selected is a mystery. A more desirable firing method and arrangement has been obtained by placing an 18,000-c.f.m. forced-draft fan driven by a 15-hp. constant-speed motor in front of each of the four boilers, on the concrete tops of the oil tanks. Fuel pumps (one a motor-driven Quimby screw pump, the other a steam-driven duplex) are in the center of the boiler room between the forced-draft fans, while oil heaters are in the basement out of the way.

We have four Heine 6,500 sq.ft. cross-drum boilers equipped with superheaters. Furnace walls are air-cooled, and air for the forced-draft fans is drawn through the walls, preheating it to about 200 deg. before it goes to the burner. Each boiler is equipped with one Peabody-Fisher wide-range mechanical atomizer capable of handling 3,120 lb. of oil an hour. This permits each boiler to operate at 200% of rating, the original designed capacity of the furnaces.

The original pulverizer installation consumed about 15,000 gross tons of coal a year, with an average actual evaporation of 9.36 lb. of water per lb. of coal. Now, approximately 3,500,000 gal. of Bunker C oil are burned a year, with an actual evaporation of 14.5 lb. of water per lb. of oil.

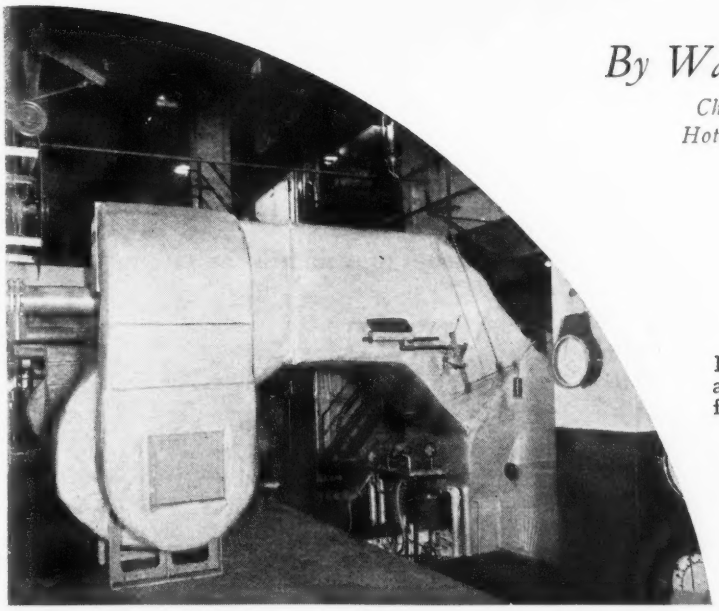
Each boiler has a CO_2 recorder to guide combustion control; without them boiler-plant efficiency would be much lower. These meters were recently rebuilt and are now serviced regularly by the manufacturer.

Originally the boilers were equipped with a standard type of combustion control. With natural draft, this device helped, but with the advent of forced draft the outfit failed entirely, although no expense was spared to bring it up to date. The device was built to maintain proper fuel-air ratio, using draft drop through the boiler as the operating medium. However, as the two boilers in use were normally operated only slightly above rating, draft drop through them was too small to cause the combustion control to follow variations in steam demand. This sluggish operation caused either a shortage or over-supply of combustion air, and ended with plenty of dense black smoke at times, very noticeable to our neighbors as well as the City Smoke Inspector.

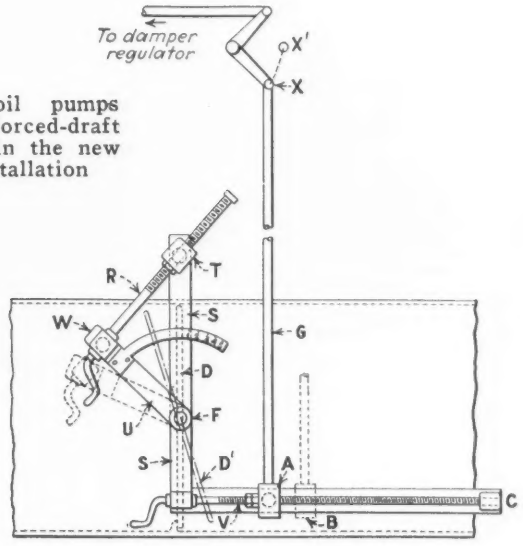
Under the circumstances, I decided to go back to the old idea of using a damper regulator to vary the quantity of both fuel (oil) and air (forced draft) according to steam pressure and at the same time hold constant minimum draft in the furnace. The first step was to build automatic controls for individual boiler uptake dampers so that constant fur-

By Warren D. Lewis

Chief Engineer,
Hotel New Yorker



Fuel-oil pumps and forced-draft fans in the new installation



Damper Control

Air duct (shown horizontally for simplicity) has a damper (D in its closed position) pivoted on shaft F. On the shaft extension is arm U, rigidly fastened to it, and another arm S-S. Arm U is attached to arm S-S at its upper end by screw-rod R operated by a handle. R is held in position by collars at W, but passes through pivoted nut T. Unscrewing R with the handle opens damper D and gives the minimum opening desired when steam pressure is high and it is only desired to maintain combustion.

A bell crank operated by a damper regulator varies damper opening between this minimum and the desired maximum. When steam pressure is high, the end of the bell-crank arm is at X; when steam pressure is low it is at X'. It carries damper rod G attached to screw-arm V (which has an adjusting handle) and opens the damper full when at A, or closes it to the minimum when at C. However, with high steam pressure and bell crank at X, in turning screw-rod V and moving damper-rod connection from A to C, the opening of damper D is not disturbed. Strictly speaking, it would be necessary to move from A to C in the arc of a circle with X as a fulcrum, but usually G is so long compared with the movement from A to C that a circular motion is not necessary.

The second adjustment with V actually changes the length of the damper-operating lever from the short A-F to the long C-F. The longer this arm becomes, the less the damper opens (maximum). Thus the fireman, by adjusting screw-rods R and V with their respective handles, can obtain a close air adjustment which will follow load and furnish the proper proportion of air for good combustion.

nace draft could be maintained regardless of fuel burned. This was accomplished by rebuilding and reinstalling some of the old equipment.

To vary the quantity of oil burned, a special adjustable plug valve was installed in each boiler-oil return line, being operated by the damper regulator. Several "plug" sizes were tried before a satisfactory one was found. Air control was the hardest problem; at first air quantity was varied by changes in fan speed, accomplished by inserting resistance in the fan-motor armature circuit. While it helped, it didn't permit proper fuel-air ratio to be maintained.

A damper had originally been installed in the forced-draft fan discharge duct of each boiler to control quantity to the burner. We tried to operate this with the damper regulator. As it was impossible to vary the quantity of air to the burner without some adjustment, I designed an adjustable damper arm which permitted firemen to vary both the maximum and minimum quantity of combustion air. This device turned out to be the "missing link" in the air-control system, and operators soon learned to make adjustments necesary to carry the desired percentage of CO_2.

When the oil-burning equipment was first started, it was impossible to maintain over 12% CO_2, but with our "home-made" equipment, the operators maintain 15% under varying loads without difficulty. Naturally, evaporation increased, so all are now satisfied that maximum practical results are being obtained.

A year of operation has proved the wisdom of taking advantage of the low price of fuel oil, as savings have paid for more than half the original cost of the oil-burning installation; in fact, the actual saving amounted to over $18,000 on an investment of approximately $30,000. There was no labor saving in changing from powdered coal to fuel oil, as a minimum crew is needed in either case, which emphasizes the splendid record of savings made. Other smaller savings are in pulverizer repairs and ash handling, as well as in fuel saved due to operating one $7\frac{1}{2}$-hp. motor driving the fuel-oil pump instead of *two* 50-hp. motors driving the unit pulverizers, 24 hr. per day. Installation of forced draft and more efficient pulverized-coal burners with forced draft will permit the plant to burn a wider variety of coal with greater efficiency. To date coal has not been burned in sufficient quantities to determine the "coal efficiency" of the plant with the new burners and forced draft. In the near future the coal burners will be put in service for a while and this much-desired information obtained.

The new installation, while providing the safety of two fuels, also increases reserve fuel supply as it is possible to store a 10-day supply of coal, and a 3-day supply of fuel oil. Changing from one fuel to another is a simple operating job which can be done in a few minutes and costs the management nothing for "alterations."

HERE'S HOW TO BALANCE

Until the future shows a better way, conservative engineers will protect their boilers from the so-called "caustic embrittlement" by maintaining the A.S.M.E. sulphate-carbonate ratio. This may not be "scientific," but it works. Mr. Sheen answers a practical question, "How shall I figure chemical requirements to maintain the safe ratio?"

FOR years, research has been seeking the final answer to so-called "caustic embrittlement." the dangerous intercrystalline cracks often found in the boiler metal of seams, laps and rivets of boilers operating on waters high in alkalinity and devoid of sulphates. Meanwhile, a sure preventive is known and will be used by all conservative engineers until something easier is available.

I refer, of course, to the sulphate-carbonate ratios recommended in the A.S.M.E. Boiler Code, Section 7, Par. CA-5. Ratios recommended are:

	Parts of sulphate present (as sodium sulphate) per part of total alkalinity (as sodium carbonate)
For pressures up to 150 lb.....	1
For pressures 150 to 250 lb.....	2
For pressures over 250 lb.....	3

This means that the sulphate *must not be less* than that indicated by the table; any higher ratio is safe. The ratio may be maintained by increasing sulphate or decreasing alkalinity. Some chemical additions will accomplish one end, some the other, some both. For example, sulphate may be increased by adding sodium sulphate. Alkalinities may be reduced by adding phosphoric acid, mono-sodium phosphate, or disodium phosphate. Simultaneous increase of sulphate and reduction of alkalinity may be accomplished by adding sulphuric acid or sodium acid sulphate (nitre cake).

No one of these methods is best in all cases. Two controlling factors are the natural characteristics of the feedwater and the method of conditioning the feedwater.

This article discusses each of these methods, shows its advantages and disadvantages, and how to figure the amount of chemical to add to maintain the proper ratio.

Use of Sodium Sulphate

Probably the commonest way to increase sulphate content is to add sodium sulphate. This treatment is more satisfactory where alkalinity must be maintained by adding conditioning chemicals.

To determine how much sodium sulphate (anhydrous) to add, use the following formula: $X = 1.06\,RA - 1.479\,SO_4$.

This formula requires a little explanation. X is the parts per million (or grains per gallon) of the chemical required to maintain the proper ratio. R is the ratio to be maintained and A the total alkalinity as calcium carbonate. SO_4 is sulphate as SO_4. Units may be in either parts per million (p.p.m.) or grains per gallon (gr. per gal.) as long as the same unit is used throughout.

Finally, note that X gives the quantity of chemical required in the *boiler water,* not the feedwater. For example, if the boiler water is 20 times more concentrated than the feedwater, the X obtained from the formula must be divided by 20 (called the "cycles of concentration") to get the quantity of chemical to be added.

Now let's apply this formula for sodium sulphate, assuming that we have a boiler water with the following analysis:

Sulphates as SO_4, 100 p.p.m.
Chlorides as Cl, 200 p.p.m.
Alkalinity as $CaCO_3$,
Carbonate, 50 p.p.m.
Hydrate, 400 p.p.m.

Assuming that the feedwater has a chloride content of 4 p.p.m., how much sodium sulphate should be added to maintain the proper ratio of 2, if the boiler operates under 200 lb. pressure?

$$X = 1.06 \times 2 \times 450 - (1.479 \times 100) = 806 \text{ p.p.m.}$$

The relative proportions of chloride in feedwater and boiler water measure the "cycles of concentration." Note that the chloride content is 200 p.p.m. in the boiler and 4 p.p.m. in the feed, giving 50 cycles. Divide 806 by 50 to get 16.1 p.p.m. of sodium sulphate to be added to the feedwater. Since 1 gal. of water weighs 8.33 lb., one part per million, expressed in pounds, is equal to 0.00833 lb. per 1,000 gal. of feedwater. Multiplying this constant by the 16.1 p.p.m., we find that the required sodium sulphate is 0.134 lb. per 1,000 gal. of feedwater.

Phosphoric Acid

Alkalinity may be reduced by adding phosphoric acid. This chemical is somewhat difficult to handle and should never be used except under the control of competent chemical engineers. However, the material is of value where a phosphate method, or where a phosphate supplementary to a colloidal method of conditioning, is employed. Feeding is rather difficult, and special metals or materials are required.

Using commercial phosphoric acid, 80% H_3PO_4 or 58% P_2O_5, the following amount is required:

$$X = \frac{0.82\,AR - 1.14\,SO_4}{R}$$

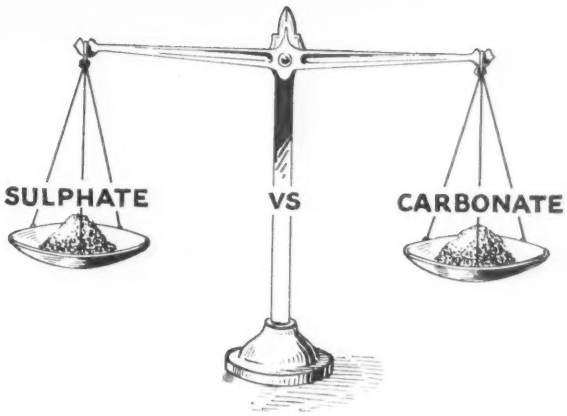
Such a material would be used where alkalinities were excessively high (either a naturally alkaline water or a zeolite-softened water).

Mono-sodium phosphate will also reduce alkalinity.

BOILER WATER

By Robert T. Sheen

Technical Director,
W. H. & L. D. Betz



It is safer to handle, and is used to advantage where phosphate is required for a phosphate method of control or as a supplement to colloidal control. This salt can be used over a wider range than phosphoric acid, as it may be easily controlled and may be used on naturally alkaline waters, or an alkaline water delivered by a zeolite-type softener or (sometimes) by a lime-soda-type softener.

The amount of this chemical required to establish the proper ratio can be calculated from the following formula, figuring on the use of anhydrous mono-sodium phosphate of 91% purity (commercial grade):

$$X = \frac{1.32\,RA - 1.84\,SO_4}{R}$$

Sulphuric Acid Requires Careful Handling

Sulphuric acid is used occasionally. If not controlled by competent chemists, it can do more damage than good. So controlled, it increases sulphate and reduces alkalinity sharply at the same time. Its chief use has been to correct ratios after zeolite softening, and in a few cases on natural waters of high alkalinity.

As has been indicated, the feeding of sulphuric acid is difficult. Yet this method is the cheapest way to establish the ratio, provided alkalinity is not furnished by chemicals added to the water for that purpose. It also increases the total solids less than any other method. The required amount of sulphuric acid can be calculated from the following formula, based on technical acid (96% H_2SO_4).

$$X = \frac{1.02\,RA - 1.42\,SO_4}{1.34 + R}$$

Nitre Cake is Cheap and Effective

Because sulphuric acid treatment is difficult and dangerous, many readers will be interested to know of some other cheap method which is also safe. A chemical not generally recognized, but often capable of safe use at a considerable saving over sodium sulphate, is sodium acid sulphate, $NaHSO_4$, or simply "nitre cake." Its cost is very low, considerably below that of anhydrous sodium sulphate. Some installations now using sulphuric acid might find it worth while to change to this chemical.

Many installations are troubled with high alkalinity, not only from the standpoint of caustic embrittlement, but also from that of foaming and carryover. Most of these would find this chemical an aid in maintaining proper sulphate-carbonate with low alkalinity.

Treatment with nitre cake gives total solids somewhat higher than those produced with sulphuric acid, but lower than with sodium sulphate. The commercial product is about 90% sodium acid sulphate with 30% available sulphuric acid and 60% sodium sulphate. Requirements can be calculated thus:

$$X = \frac{2.68\,RA - 3.73\,SO_4}{2.68 + R}$$

Solving this formula with the same data as used for the sodium sulphate on the preceding page, we find an answer of 436 p.p.m. of sodium acid sulphate, whereas 806 p.p.m. of the sodium sulphate would be required. With 50 cycles of concentration this would be equivalent to 8.7 p.p.m. of the nitre cake to be added to the feedwater, or 0.0725 lb. per 1,000 gal. The sodium sulphate, on the other hand, would require 0.135 lb. per 1,000 gal.

Note that the nitre cake, in this instance, reduces alkalinity from the 457 p.p.m. of the original analysis to 287 p.p.m. in the final. The total sulphate in the boiler water will be 414 p.p.m., as compared with 645 p.p.m. when the sodium sulphate is used.

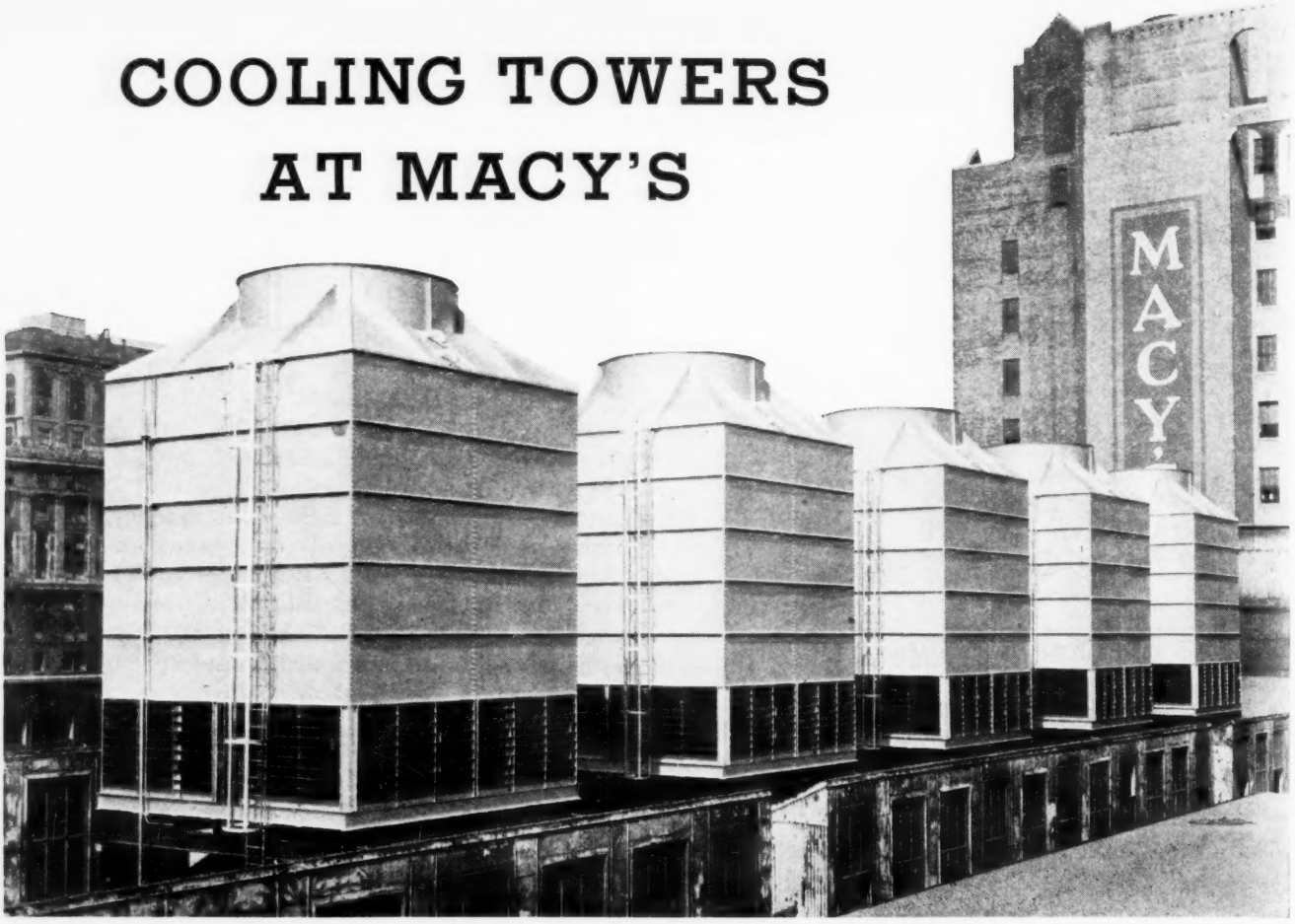
Disadvantage of Nitre Cake

However nitre cake is rather corrosive; extreme care must be taken in handling this chemical and in the feeding apparatus. Shot methods of feeding are generally used. With proper care, its corrosiveness will give little difficulty. The chemical has been in use in several plants under the recommendations of the author, with very satisfactory results.

It must not be assumed that any one of these chemicals can be arbitrarily chosen, and it is most important that selection of the methods to be employed be based upon careful analysis and study of local conditions.

[The final test of the sulphate-carbonate ratio is, of course, the actual amount of sulphate and alkalinity in the boiler water. The formulas will indicate very closely how much of the selected chemical should be added to obtain this ratio. In practice, however, the boiler water itself should be tested from time to time, and the amount of chemical added made slightly more or less than that indicated by the formula to bring the ratio into line—Editor.]

COOLING TOWERS AT MACY'S



By Fred D. Mosher and R. Wellbrock

Engineering Dept., R. H. Macy & Co.

Five towers installed by this New York department store 2½ years ago have saved $27,000 a year

IN 1931, from May to October, the air-conditioning plant at R. H. Macy & Co., New York department store, used 10,000,000 cu.ft. of purchased water for cooling purposes. This was repeated for the same period in 1932. Water was purchased from the City at $1.00 per 1,000 cu.ft. An increase in the cost of water of $0.50 per 1,000 cu.ft. was announced by the City in 1933 to take effect in January, 1934. Before the increase in water rates had been announced, Macy engineers had estimated that considerable savings could be effected by installing cooling towers. The higher rates accelerated the plans and it was decided to install the towers immediately.

Due to an increasing power load, the addition of a 1,000-kw. generating unit to supplement the existing units had been under consideration for some time. Decision to install the cooling towers made operation of a condensing turbine possible, since sufficient water for condensing purposes would then be available. Seven reciprocating corliss engines with two diesel engines made up the generating capacity of the plant. Up until this time, practically all exhaust steam from the corliss engines had been lost to the atmosphere during the summer months, and only part of it had been used for building heating during the winter. Since this exhaust steam could be used for generating purposes, the foundation for a mixed-pressure turbine was laid in May, 1933. The turbine was put in commission three months later when the last of the five cooling towers was completed.

Changes in the Building Code had permitted the erection of cooling towers on the building roof. The plans called for the towers to be placed on the roof of the 10-story or Broadway Building of the store. Much preliminary reinforcing work had to be done before the actual installation began, since the structure of the building was cast iron and had not been designed to carry a load such as the towers would impose. Even after reinforcing, the roof load was limited, therefore these conditions kept the weight of the towers within a definite amount. As the towers had to handle a specific quantity of water they consequently

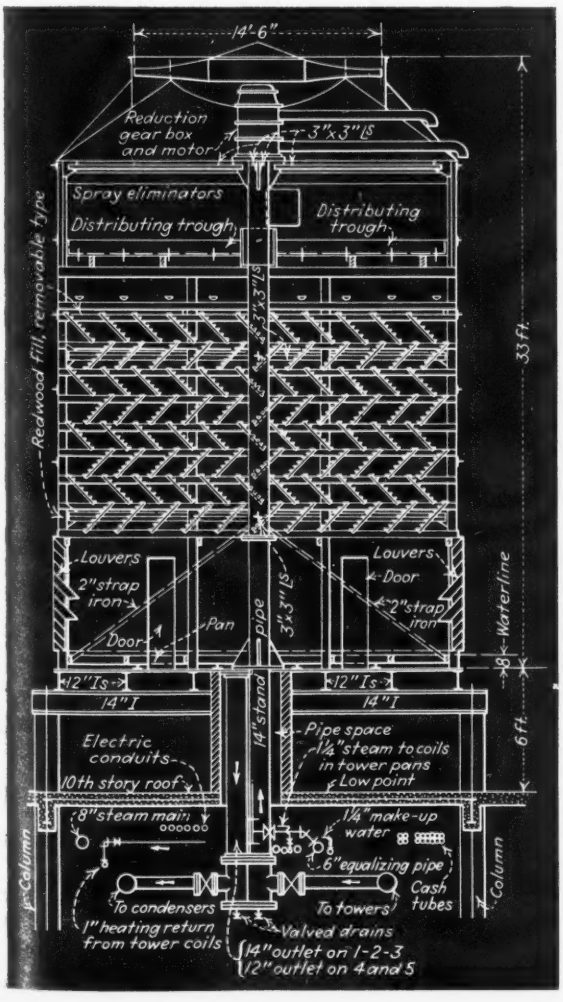
had to be of special design and construction to meet load requirements.

In June, 1933, the first three towers were put in operation, supplying cooling water for the air-conditioning plant. Two more towers were added in August of the same year to supply water for the condenser of the turbine, which was then ready to operate. Under present conditions, the turbine gets water from the towers 11 hr. a day all year 'round. The air-conditioning plant receives water for 8 hr. a day during the warm weather. The turbine towers may be switched to the air-conditioning plant and vice versa, and are operated in this way when cleaning is being done during cold weather.

The towers are 32 ft. high and 22 ft. 6 in. square. Shells are of copper-bearing steel construction coated to resist corrosion. Filling is of special type consisting of a zig-zagging structure of California redwood. Air-inlet louvre sections are 6 ft. high in the four sides at the base of each tower. The water reservoir at the base of each tower is 8 in. deep and of the same area as the tower.

Two 1,150-g.p.m. centrifugal pumps for the air-conditioning towers and one 2,700-g.p.m. centrifugal pump for the turbine towers circulate water to be cooled. The turbine pump operates at 1,150 r.p.m., and the air-conditioning tower pumps operate at varying speeds from 900 to 1,750 r.p.m. Cooling water for air conditioning flows by gravity from the towers to the condensers of the cooling units and then to the condenser of the exhaust steam turbines driving the refrigeration compressors. Water for the turbine flows by gravity through the condenser and is pumped back to the towers. Make-up water is supplied through a ball float by gravity from the house tanks in an ajoining building.

Section through a cooling tower



Air for the towers is circulated by induced-type fans at the tops of the towers. Fans are of special design with propeller-type blades 14 ft. 6 in. in diameter, and are driven by d.c. motors through a reduction gear. The motors are set on extensions of the risers which carry the water from the pump discharges to the tower distributing system. Fan speed can be varied from 104 to 312 r.p.m. by varying motor speed from 600 to 1,800 r.p.m. These fans give quieter operation than the sideblown type. Special spray eliminators keep water from being blown out through the discharges.

Usual air circulation through towers of this type is at a velocity of 400 to 500 ft. per min. Restrictions of this installation made necessary a velocity of 1,000 ft. per min. at the discharge.

A study of the towers made this summer showed that the system was supplied adequately with clean cool water under the most extreme conditions. On one of the hottest days, when the two air-conditioning units were delivering their full loads of 333 tons each, water entered the towers at 119 deg. and left at 81 deg. At the same time, the turbine was operating at full load and receiving water from its towers at 83 deg. F. and returning it at 115 deg. Outside temperature was 90 deg. dry bulb with a wet bulb of 75. Store temperature was maintained at 80 deg. 2,300,000 cu.ft. of store space is air conditioned, comprising the basement and main floor. Air circulated is 245,000 c.f.m.

Because the tower installation permitted addition of the turbine, which resulted in a great reduction in fuel-oil consumption, power generation costs were materially lowered. Added to this were the savings effected by substituting tower water for purchased water. After more than two years of operation, estimated savings are more than $27,000 a year.

Additional savings are predicted on circulating water for the two diesel engines by using tower water for these machines when the air-conditioning plant is not operating during the cold weather and after store hours. When air conditioning is extended to three additional selling floors, it is planned to install an additional tower and circulating pump to provide the necessary water.

COMPRESSOR FREEZE-UPS—Watch your air compressor during winter months just as you do your automobile. If the water in the cylinder jacket freezes, a cracked cylinder or cylinder head is the probable consequence, entailing expensive replacements and repairs. Therefore, if the compressor is located where there is any possibility of freezing, always make sure that all water is thoroughly drained from the cylinder jacket when the compressor is not in operation; and this caution also applies, of course, to a compressor which may temporarily be out of service and in a building where there is no heat.—*Bulletin of Pennsylvania Pump & Compressor Co.*

UNCHAPERONED TURBINES

By John P. Topolosky
Steam Engineer,
St. Croix Paper Company

POWER engineers are accustomed to steam-turbine operation supervised by an attendant, but at the plant of the St. Croix Paper Co., Woodland, Me., this practice has been abandoned. Main power units comprise one 475-hp. and two 450-hp. geared steam turbines driving paper machines, a 600-kw. and a 3,000-kw. geared turbine-generator. The large unit is near the boiler room and is operated by these engineers. The other four units are in the mill near the paper machines. One is about 1,500 ft. away from the central control board in the boiler room, the others about 200 ft. away.

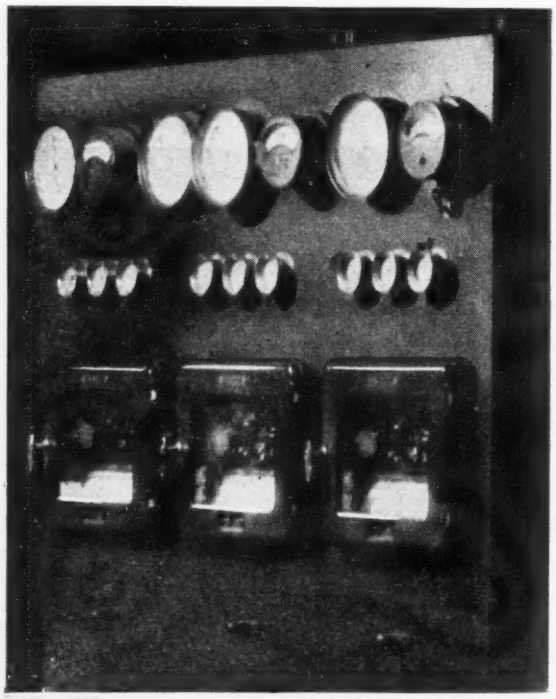
Obviously, it would not be satisfactory to have an operator give his full time to operating these units because of the distance they are apart. If a machine required immediate attention, the operator probably would not be at that machine. It was, therefore, decided to operate the machines without an operator by putting them under attention of the boiler-room engineers.

On a meter and control board in the boiler room are two 16-point recording thermometers that record the temperature of the eight bearings on each turbine and its reduction gear. A 6-point oil-level recorder shows oil level in the six oil reservoirs on the paper-machine units. Nine small pressure gages show the oil pressure at the bearings, there being three gages for each unit. A tachometer and a speed control for each turbine are also provided on the board, along with pressure gages to show steam pressure on the turbine side of the throttle valve. The latter gives an indication when turbine steam-line strainers are becoming clogged. When the difference between readings of these gages and the steam-header gage reaches a predetermined amount, the strainers are cleaned.

When paper machines go into service on Monday morning, the turbines are started by a shift engineer who supervises their operation for about one hour, until normal running conditions are attained. After that, speed adjustments of the machines are made by the boiler-room engineer from the control board, on instructions given by the paper makers. Speed adjustment is by the usual type of governor-synchronizing motor and is limited to a range of about 15% full-load speed. After the paper machines are in service, they operate at practically constant speed until they are shut down for the week-end.

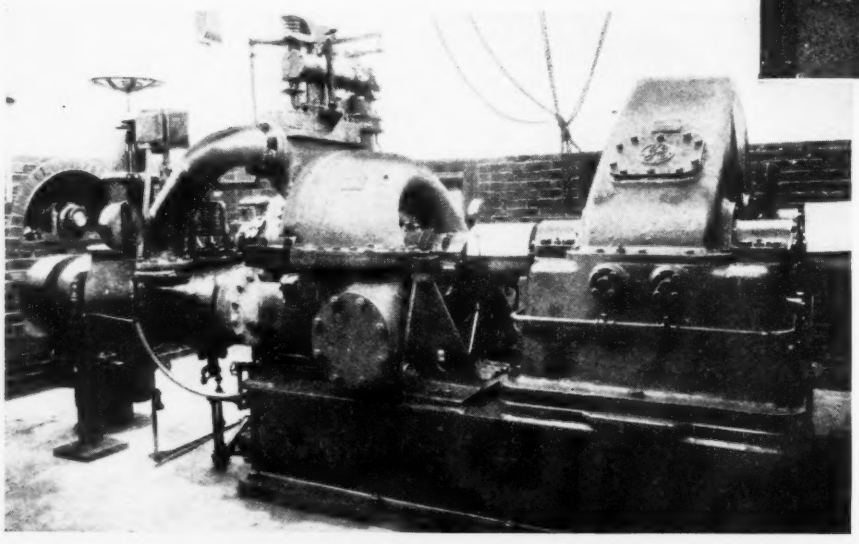
Oil-reservoir level recorders are equipped with high- and low-level alarms and the bearing temperature recorders give alarms when bearing temperatures exceed 175 deg. F. The thermometers are located in the bearing metal directly below the journals, consequently are very sensitive to bearing-temperature changes.

At all times the recorders and indicating gages show operators the condition of the turbine-lubricating systems. Generally the operators will notice any indications of abnormal conditions before they occur. If for any reason, something happens that causes a bearing temperature to rise quickly without the operator's



Above—Turbine control board in the boiler room

On this board are two 16-point bearing temperature recorders; one 6-point lubricating-oil reservoir-level recorder; 9 small lubricating-oil pressure gages; 3 indicating tachometers for turbine speed; 3 steam-pressure gages for pressure at the turbines; a clock and 3 paper-machine turbine-speed control switches



Left — One of the 450-hp., geared turbines operated from a control board in the boiler room

notice, the alarm will sound and call immediate attention to the fault. By looking at the temperature recorder, the operator can quickly determine the bearing in trouble and go directly to it.

This has happened but once during the two years that this system has been in service and was caused by stoppage of an oil valve. This trouble was cleared so quickly by an attendant that the bearing was not injured. The unit was not shut down until the week end, when the bearing was inspected. Without the recorder, the bearing would have been destroyed, even if an attendant had been near the turbine. Saving this one bearing more than repaid the remote-control system cost for all four units, by preventing an expensive repair job on the bearing and a shut down.

The turbines are inspected twice each shift by the operators just after starting work and before leaving, and once a year they are given a general inspection and checking, otherwise the remote-control system is depended upon entirely.

ELEVATOR HOIST ROPES MAKE MILEAGE RECORD

ELEVATOR and rope engineers agree that size of sheaves, groove design, number and kind of bends all have an effect upon wire rope life. Just to what extent these factors have an influence may not be generally realized. A case in point is found in the long life obtained for elevator hoist ropes in the Municipal Building in New York. Some of these ropes have a car mileage record of nearly 190,000 mi.

In this building there are a total of 32 passenger elevators; 16 high-rise cars operate express from the ground to the 14th floor, and local to the 25th floor. The machines are designed for 3,000-lb. capacity, operate at 500 f.p.m., and are of the car-switch operated, geared, drum-traction type. The drums, which are 48 in. in diameter, have a single helical U-groove. Each of the six ropes of a car makes 2.5 wraps around the drum and goes to the counterweights. As the drum turns, the ropes travel along it very much the same as does a nut on the thread of a bolt.

These elevators went into operation in 1913, and the hoisting ropes were not changed on any of them until 1931. These ropes are Roebling $\frac{5}{8}$-in., traction-steel, 6x19, Warrington construction. One of the first sets of ropes to be removed had gone 176,000 mi. When a sample of these ropes was tested, it broke at 20,188 lb., 85% of its catalog strength. The reduction of metals due to wear was only 6%, and the ropes showed no signs of internal corrosion, consequently they were still in safe condition.

Other ropes removed last year had operated up to nearly 190,000 mi. These showed 8.5% loss of metal with some evidence of fatigue of the wires, but nothing dangerous. There was no internal corrosion and very little abrasion between strands. The latter indicated that the hemp core had retained its original diameter to a remarkable degree.

None of the ropes were removed because of broken wires or other unfavorable outside conditions. Because of the long time that they had been in service and their exceptional mileage, city engineers responsible for the elevators began to question their safety. A very careful inspection made of them under a strong light and a magnifying glass failed to find broken wires. As the ropes had operated for a mileage so great that there was no experience to indicate what their internal condition might be, it was feared that fatigue and failure might occur suddenly. For safety's sake it was decided to replace them. Tests have shown that none of them was in a condition other than that evident from the study of their exteriors.

These ropes were never lubricated during their 20 years of service. Since the sample tested showed no signs of internal corrosion, it is evident that if elevator rope is properly lubricated when it is made, this is sufficient for its life under normal conditions.

It is quite evident that the ropes are not of exceptional material and construction. They showed signs of fatigue at the shackles in the car crossheads and were resocketed several times because of broken wires there. These shackles are of the fixed type without a swivel. Operation of the car switch, a single-step dynamic brake and an unusually large mechanical brake, produced very severe conditions for the ropes when stopping the car. Because of these conditions, when we look for an answer to the long rope life, it must be found in the large size of the drums, their grooving and the number of turns on them. Rope bending stresses were unusually low because drum diameter is 48 in. The ropes were in contact for 2.5 turns on the drum, as compared to two half-turns on the full-wrapped traction machine and one-half turn on the V-groove machine. Because of the large rope area in the groove, the loading on each individual wire in contact with the drum was also low. As a result, the rate of fatigue in the wires and the wear on them was very low and their factor of safety remained high.

Modern high-speed elevators cannot be designed for such ideal rope conditions as described, therefore shorter rope life, with which we are familiar, is the result. There are, of course, many factors under control of the elevator operating engineer that, if given proper attention, will greatly increase rope life. Lack of proper attention to these factors is frequently the cause of short rope life.

SPEAKING OF POWER

• HERE are some facts and a conclusion. . . . Business activity is now up 44% from the low level of the depression (March 18, 1933). Utility loads are 2.7% above the all-time pre-depression high and are rising steadily. Many utility power equipment orders are pending. Same with industrials. Most makers of power equipment are still short-staffed and teams of skilled engineers and workers cannot be enlarged efficiently overnight. . . . All this suggests a coming jam of power-equipment orders that may cause serious delay in delivery, pinching on loads, operating with dangerously small reserve and the emergency use of run-down and unreliable obsolete equipment.

Each year *Power* publishes a thirteenth Mid-December number for good measure. The editors aim to make it a reference work you will want to keep. This year, as usual, the mid-December *Power* will summarize the A.S.M.E. and A.S.R.E. annual meetings. The review of new equipment of 1935 will be altered and enlarged to include *all* new power equipment of the year. . . . In addition there will be two brand new features: a convenient reference list of the year's new catalogs and bulletins, and an armchair review, written for easy reading, of 15 years of power progress.

Engineers are thinking a lot about jobs these days, and in general, more hopefully than a few months ago. . . . Last month I reported an increased demand for technical engineers in Chicago. Now *Product Engineering* comes along with the news that employment of designing engineers is 21% over 1934 and almost double the low of 1932. These figures are based on a survey of 425 companies. . . . This fact, when you come to think of it, means more than jobs for engineers. It means a larger output of obsolescence, something the engineer manufactures every time he designs a better machine. . . . By the way, one boiler manufacturer has added eleven draftsmen, another six.

E. A. Ellwood, chief engineer of Thomas A. Edison, Inc., writes in that *Power* is getting better all the time, but wishes we could give a lot more detailed power costs in our operating articles. He wonders whether the authors "don't know their complete costs or are afraid someone beside themselves may benefit by their knowledge." We sometimes wonder too. The contributor who offers detailed and carefully checked information on the individual costs of his power services is the man we are looking for.

Looking ahead a bit, C. J. Stilwell, vice-president of Warner & Swasey Co. and president of the National Machine Tool Builder's Association, predicts that next spring will see a substantial improvement in employment throughout the country and a sharp decline in the number of people on relief. He bases this prophecy on this year's remarkable influx of machine-tool orders and on previous experience showing that modernization of industry reduces selling costs, builds sales volume and thereby creates (as in the case of the automobile) thousands of service jobs taking care of the things produced.

Still speaking of jobs, the employment department of the American Association of Engineers (Chicago convention) predicts a coming acute shortage of skilled workers in industry, because most manufacturers did not hold an adequate number of men in training during the hard times. . . . Looks as though every factory manager will have to turn school teacher on the side and train his own men.

In spite of all this, I can't help wondering how the hundreds of young men now taking intensive courses in diesel-engine operation, in schools all over the country, are going to find diesel jobs. On the one hand, you can't turn out a diesel designer in two or three months (this generally is not attempted). On the other, the operating man can rarely get by as a diesel specialist alone. In industry, at least, the diesel is always hooked to other machinery and associated with all kinds of power equipment. More often than not, the man looking for a diesel job will find that he is expected to know a lot about electricity, pumping, refrigeration, heating and ventilating, air compressing—probably boilers also. . . . It seems to me that this special diesel training would be more useful when added to the existing abilities of an all-around experienced power engineer.

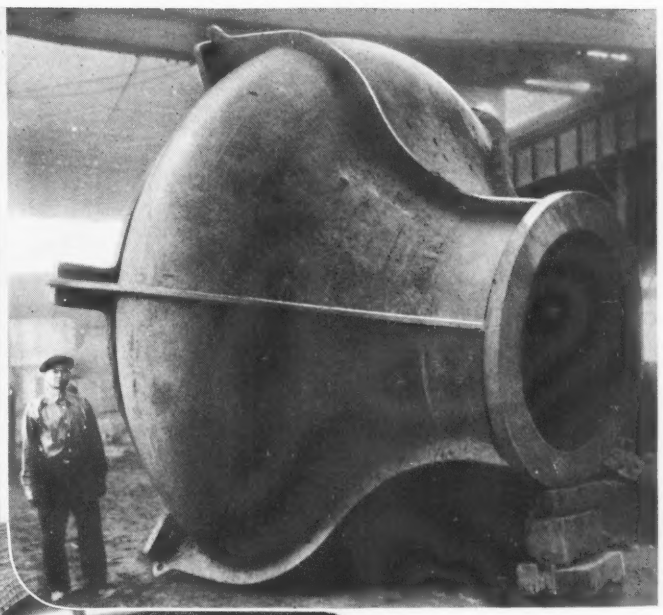
Farmers raise pigs and kill them for a government bonus. They plow under cotton on the same basis. Engineers, too, get paid for destroying their own handicraft. If you don't believe it, turn to page 661 and see the picture of the elaborate contraption installed at Boulder Dam to destroy 100,000 hp. if and when the need arises.

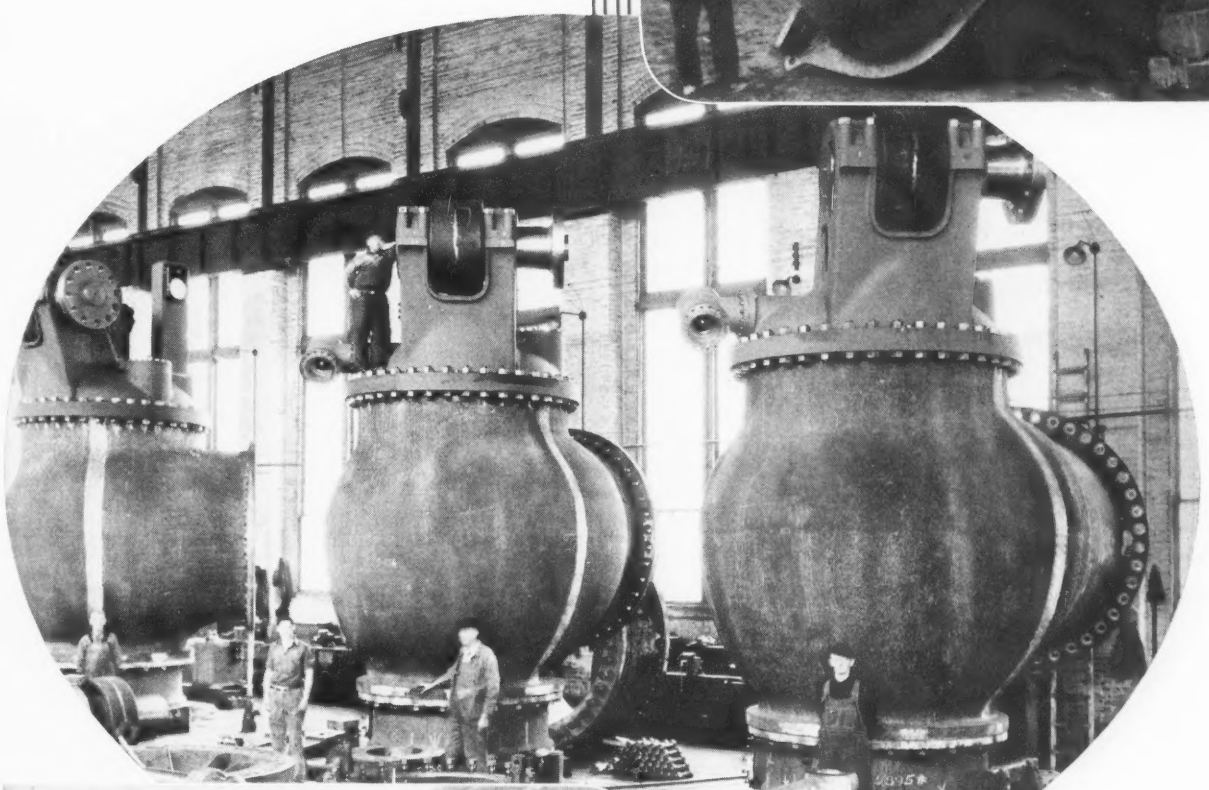
Wide interest has been shown in the refractories section of the September number of *Power*, so much so, in fact, that a supplementary section will be published in March to give additional information on suspended walls, arches and water walls. Although four pages of the September Refractories section were used to illustrate various types of wall and arch construction, it was physically impossible, in this space, to show all of the types available, and some of considerable importance were omitted. The March presentation will combine with that of September to give a more complete picture.

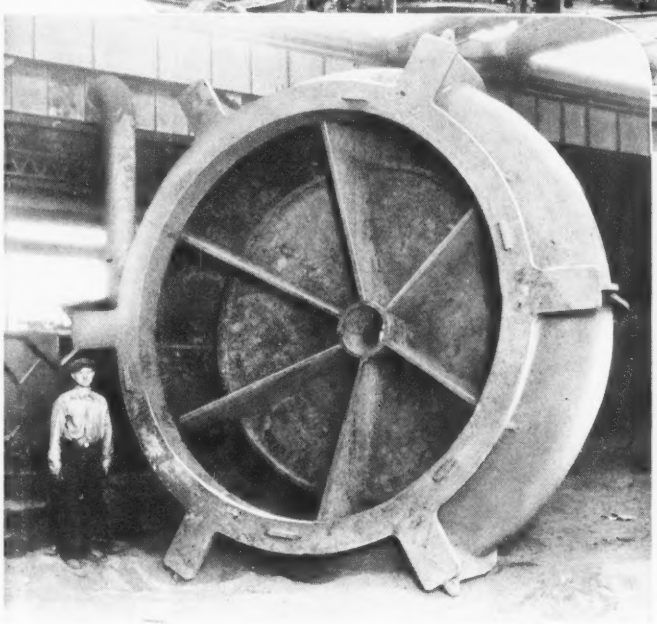
PHIL SWAIN

Editor

KILLS 100,000 HP.







Two views of one of four "energy absorbers" for the four 115,000-hp. Boulder Dam turbines, and, at center, the relief valves below which the absorbers fit. Water capable of doing 100,000 hp. of work rushes into the neck of the casting at top in case the turbine is suddenly shut down. It divides and flows around the central cone, then loses its energy by impact with itself at the base of the cone, shown at left. Each absorber weighs 55,700 lb.

Photographs courtesy S. Morgan Smith Co.

RILEY PROGRESS
IN THE BOILER INDUSTRY

RILEY IS NOW UNDENIABLY ONE OF THE LEADERS

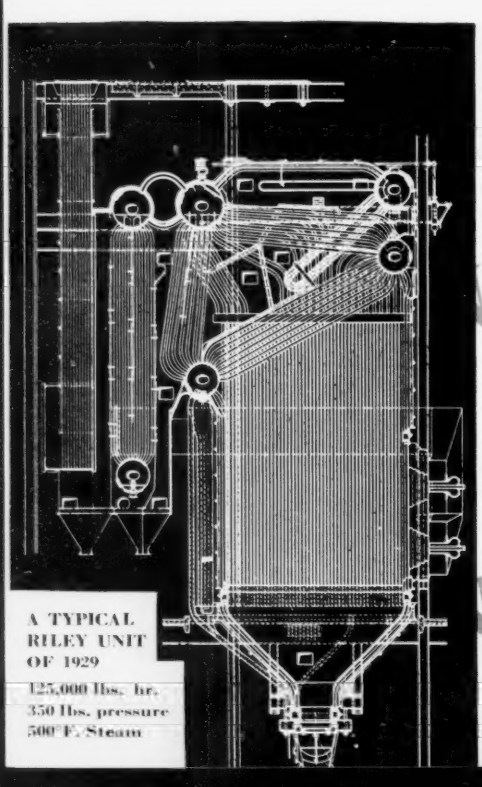
The swing of plant after plant to Riley Steam Generating Units during the past few years has undeniably established Riley as one of the leaders of the boiler industry. A swing which has reached such magnitude in 1935 as to cause sales of Riley Steam Generating Equipment for 1935 to exceed by approximately twenty per cent, sales of the boom year of 1929. Riley, today, is installing many of the country's outstanding boilers, units which generate close to a half million pounds of steam per hour at steam pressures of 850 pounds and total steam temperatures of 810°F.

It takes quality equipment to make such progress and gain such recognition, especially under prevailing business conditions. Equipment which produces such outstanding results as to demand its selection . . . equipment which gives complete satisfaction with absolute reliability . . . equipment which has everything it ought to have and something no other equipment has. It takes Riley equipment.

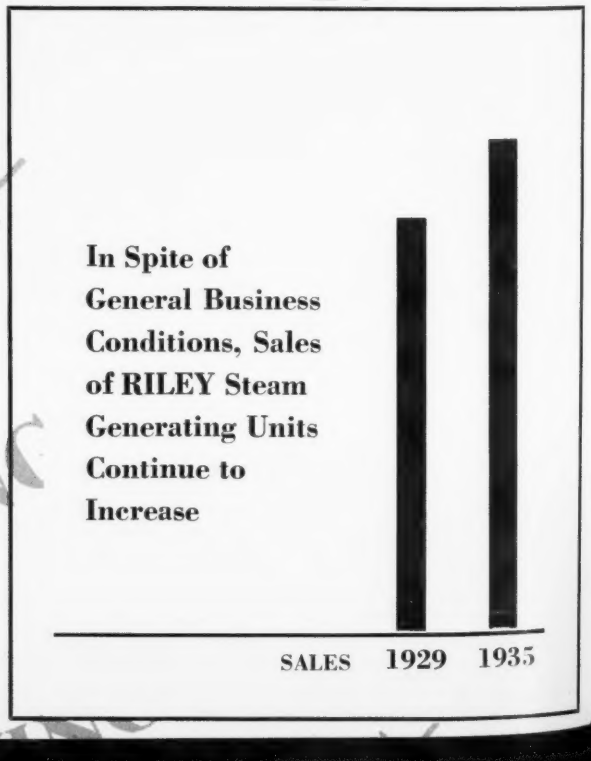
Engineers everywhere are talking about the many outstanding installations recently made by Riley and the remarkable results being obtained by these installations. Real achievement demands recognition. The approval the engineering profession has given Riley equipment, spurs on Riley engineers to even greater achievements . . . to design and build better steam generating units each succeeding year.

Riley is looking to the future, not living in the past. The Riley organization fully appreciates the recognition given its products and will continue its progressive policy.

Today's demand for reduced costs requires the modernization of power plant equipment. Have a consulting engineer make a survey of your power plant. You may be surprised at the tremendous savings possible. Be sure to consult Riley engineers about steam-generating and fuel-burning equipment.



A TYPICAL RILEY UNIT OF 1929
125,000 lbs. hr.
350 lbs. pressure
500°F. Steam



Typical Riley Units of 1935

between 1929 and 1935 Riley has made the following outstanding Installations

W. Va. Pulp and Paper Co.
LUKE, MD.
375,000 lbs. per Hour
631 lbs. Pressure—700°F. Steam

W. Va. Pulp and Paper Co.
COVINGTON, VA.
375,000 lbs. per Hour
600 lbs. Pressure—750°F. Steam

Standard Oil Co. of Calif.
SAN FRANCISCO, CALIF.
125,000 lbs. per Hour
850 lbs. Pressure—760°F. Steam
Stone & Webster Engineering Corp., Engineers

Large Eastern Oil Refinery
NEW JERSEY
300,000 lbs. per Hour
646 lbs. Pressure—740°F. Steam

Titanium Pigment Co.
SAYREVILLE, N. J.
125,000 lbs. per Hour
448 lbs. Pressure—637°F. Steam
Ford, Bacon and Davis, Engineers

Savannah Sugar Refining Co.
SAVANNAH, GA.
100,000 lbs. per hour
325 lbs. Pressure—620°F. Steam

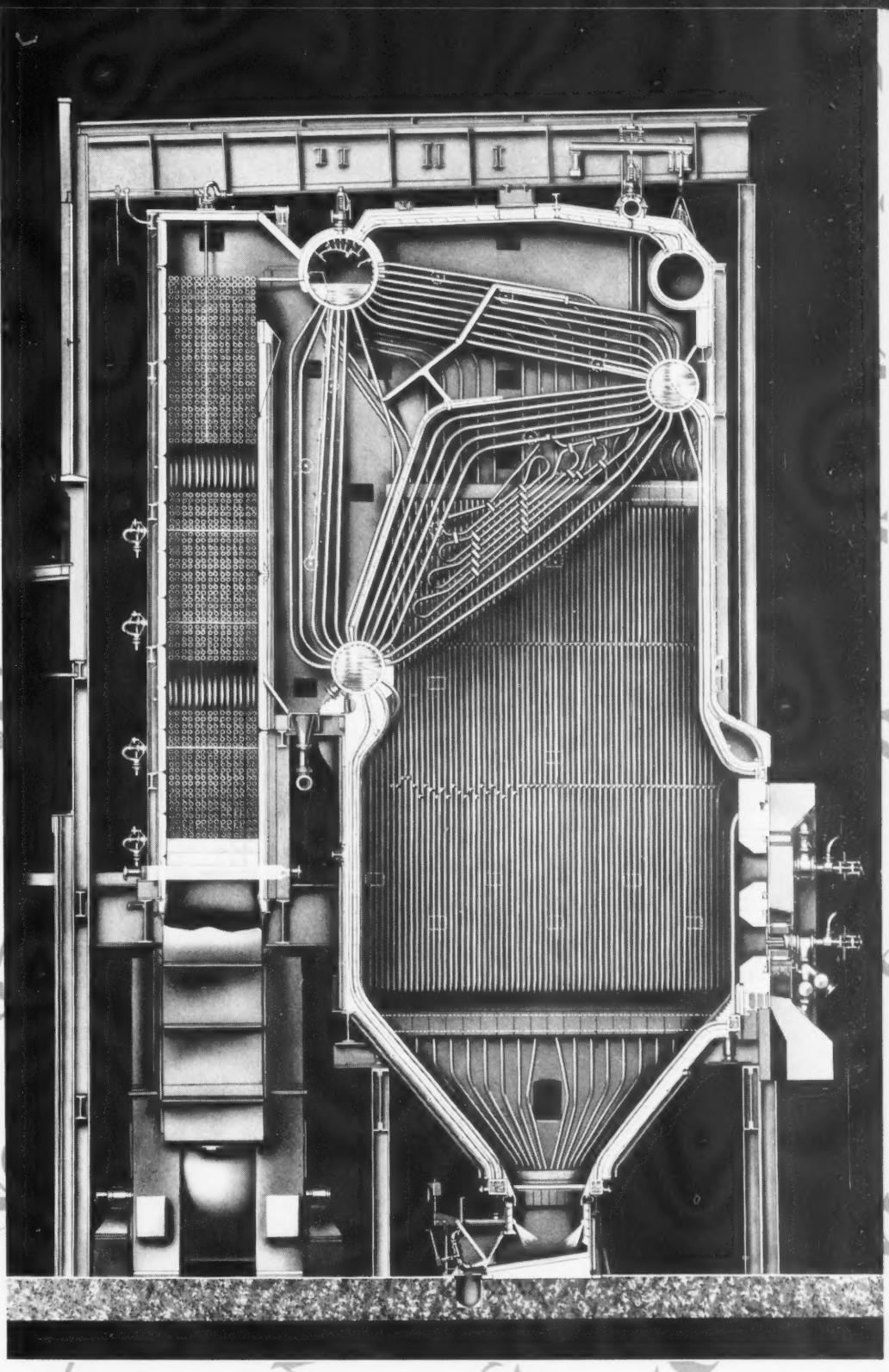
Pennsylvania Sugar Refining Co.
PHILADELPHIA, PA.
350,000 lbs. per Hour
400 lbs. Pressure—505°F. Steam

Carbide & Carbon Chemicals Corp.
CHARLESTON, W. VA.
80,000 lbs. per Hour
600 lbs. Pressure—650°F. Steam

Lynn Gas & Electric Co.
LYNN, MASS.
205,000 lbs. per Hour
430 lbs. Pressure—810°F. Steam
Stone & Webster Engineering Corp., Engineers

A Few Other Recent Riley Installations

Celanese Corporation
Owens Illinois Glass Co.
Whippany Paperboard Co.
American Laundry Machinery Co.
Crystal Tissue Co.
Arnold Print Works
Beechnut Packing Co.
Crompton & Knowles Loom Works
Kalamazoo Vegetable Parchment Co.
Ames Worsted Co.



RILEY STEAM GENERATING UNIT
INSTALLED AT A LARGE EASTERN OIL REFINERY
300,000 lbs. of Steam per hour—646 lbs. Pressure—740°F. Steam
A Typical Modern Riley Unit

RILEY STOKER CORPORATION

COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR HEATERS
ECONOMIZERS • WATER COOLED FURNACES • STEEL-CLAD SETTINGS • FLUE GAS SCRUBBERS

© POWER

Torque for Various Horsepowers and Speeds

R.P.M.	HORSE POWER																						R.P.M.
	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20	22	24	26	28	30	35	40	45	
100	630	1261	1891	2521	3151	3782	4412	5042	5672	6303	7563	8824	10084	11345	12605	13866	15126	16387	17647	18908	22059	25210	28361	**100**
150	420	840	1261	1681	2101	2521	2941	3361	3781	4202	5042	5882	6723	7563	8403	9244	10084	10924	11765	12605	14706	16807	18907	**150**
200	315	630	945	1261	1575	1891	2206	2521	2836	3151	3782	4412	5042	5672	6303	6933	7563	8193	8824	9454	11029	12605	14181	**200**
250	252	504	756	1008	1260	1513	1765	2017	2269	2521	3025	3529	4034	4538	5042	5546	6050	6555	7059	7563	8824	10084	11345	**250**
300	210	420	630	840	1050	1261	1471	1681	1891	2101	2521	2941	3361	3782	4202	4622	5042	5462	5882	6303	7353	8403	9454	**300**
350	180	360	540	720	900	1080	1261	1441	1621	1801	2161	2521	2881	3241	3601	3962	4321	4682	5042	5402	6303	7203	8103	**350**
400	158	315	473	630	788	945	1104	1261	1418	1576	1891	2206	2521	2836	3151	3466	3782	4097	4412	4727	5515	6303	7090	**400**
450	140	280	420	560	700	840	980	1120	1261	1401	1681	1961	2241	2521	2801	3081	3361	3641	3922	4202	4902	5602	6303	**450**
500	126	252	378	504	630	756	882	1008	1134	1261	1513	1765	2017	2269	2521	2773	3025	3277	3529	3782	4412	5042	5672	**500**
550	115	229	344	458	573	688	802	917	1031	1146	1375	1604	1833	2063	2292	2521	2750	2979	3209	3438	4011	4584	5156	**550**
600	105	210	315	420	525	630	735	840	945	1050	1261	1471	1681	1891	2101	2311	2521	2731	2941	3151	3676	4202	4727	**600**
650	97	194	291	388	485	582	679	776	873	970	1164	1357	1551	1745	1939	2133	2327	2521	2715	2909	3394	3879	4363	**650**
700	90	180	270	360	450	540	630	720	810	900	1080	1261	1441	1621	1801	1981	2161	2341	2521	2701	3151	3601	4052	**700**
750	84	168	252	336	420	504	588	672	756	840	1008	1176	1345	1513	1681	1849	2017	2185	2353	2521	2941	3361	3782	**750**
800	79	158	236	315	394	473	551	630	709	788	945	1103	1261	1418	1576	1733	1891	2048	2206	2363	2757	3151	3545	**800**
850	74	148	222	297	371	445	519	593	667	741	889	1038	1186	1335	1483	1631	1780	1928	2076	2224	2595	2966	3337	**850**
900	70	140	210	280	350	420	490	560	630	700	840	980	1120	1261	1400	1541	1681	1821	1961	2101	2451	2801	3151	**900**
950	66	133	199	265	332	398	464	531	597	663	796	929	1061	1194	1327	1460	1592	1725	1858	1990	2322	2654	2985	**950**
1000	63	126	189	252	315	378	441	504	567	630	756	882	1008	1134	1261	1387	1513	1639	1765	1891	2206	2521	2836	**1000**
1100	57	115	172	229	286	344	401	458	516	573	688	802	917	1031	1146	1261	1375	1490	1604	1719	2005	2292	2578	**1100**
1200	53	105	158	210	263	315	368	420	473	525	630	735	840	945	1050	1155	1260	1366	1471	1576	1839	2101	2363	**1200**
1300	48	97	145	194	242	291	339	388	436	485	582	679	776	873	970	1067	1164	1261	1357	1454	1697	1939	2182	**1300**
1400	45	90	135	180	225	270	315	360	405	450	540	630	720	810	900	990	1080	1170	1261	1351	1576	1801	2026	**1400**
1500	42	84	126	168	210	252	294	336	378	420	504	588	672	756	840	924	1008	1092	1177	1261	1471	1681	1891	**1500**
1600	39	79	118	158	197	236	276	315	355	394	473	551	630	709	788	867	945	1024	1103	1182	1379	1576	1773	**1600**
1700	37	74	111	144	185	222	260	296	334	371	445	519	593	667	741	816	890	964	1038	1112	1298	1483	1668	**1700**
1800	35	70	105	140	175	210	245	280	315	350	420	490	560	630	700	770	840	910	980	1050	1225	1401	1576	**1800**
1900	33	66	100	133	166	199	232	265	299	332	398	464	531	597	663	730	796	862	929	995	1161	1327	1493	**1900**
2000	32	63	95	126	158	189	221	252	284	315	378	441	504	567	630	693	756	819	882	945	1103	1261	1418	**2000**
2100	30	60	90	120	150	180	210	240	270	300	360	420	480	540	600	660	720	780	840	900	1050	1200	1351	**2100**
2200	29	57	86	115	143	172	201	229	258	286	343	401	458	516	573	630	688	745	802	859	1003	1146	1289	**2200**
2300	27	55	82	110	137	164	192	219	247	274	329	384	438	493	548	603	658	712	767	822	959	1096	1233	**2300**
2400	26	53	79	105	131	158	184	210	236	263	315	368	420	473	525	578	630	683	735	788	919	1050	1182	**2400**
2500	25	50	76	101	126	151	176	202	227	252	302	353	403	454	504	555	605	655	706	756	882	1008	1134	**2500**
2750	23	46	69	92	115	138	160	183	206	229	275	321	367	413	458	504	550	596	641	688	802	917	1031	**2750**
3000	21	42	63	84	105	126	147	168	189	210	252	294	336	378	420	462	504	546	588	630	735	840	945	**3000**
3250	19	39	58	78	97	116	136	155	175	194	233	272	310	349	388	427	465	504	543	582	679	776	873	**3250**
3500	18	36	54	72	90	108	126	144	162	180	216	252	288	324	360	396	432	468	504	540	630	720	810	**3500**
3750	17	34	50	67	84	101	118	134	151	168	202	235	269	303	336	370	403	437	471	504	588	672	756	**3750**
4000	16	32	47	63	79	95	110	126	142	158	189	221	252	284	315	347	378	410	441	473	552	630	709	**4000**
4250	15	30	44	59	74	89	104	119	133	148	178	208	237	267	297	326	356	386	415	445	519	593	667	**4250**
4500	14	28	42	56	70	84	98	112	126	140	168	196	224	252	280	308	336	364	392	420	490	560	630	**4500**
4750	13	27	40	53	66	80	93	106	119	133	160	186	212	239	265	292	318	345	372	398	464	531	597	**4750**
5000	13	25	38	50	63	76	88	101	113	126	151	177	202	227	252	277	303	328	353	378	441	504	567	**5000**

$$\text{Torque Q (in in.-lb.)} = \frac{63{,}025 \times hp.}{r.p.m.}$$

Example: Given a 10-hp., 900-r.p.m. motor with 10-in. pulley for belt drive. To find full-load motor torque, enter table at 10 hp. and follow down to line for 900 r.p.m. Read 700 in.-lb., equals pounds of turning effort acting at 1-in. radius. 700 divided by 5 in. (pulley radius) gives 140 lb., effective pull in belt.

Take same motor with 6-in. pitch-diameter gear. Divide 700, obtained as above, by 3 in. (pitch radius) and obtain 233 lb. force on gear teeth at pitch radius. This value is also the full-load pull in a chain running on a 6-in. sprocket. Assume a 2-in. motor shaft, then the full-load force tending to shear the key is 700 divided by 1 in. (shaft radius) equals 700 lb.

Courtesy The Louis Allis Co.

POINTERS ON PAINT

STORING—Keep paint intended for use at 60 deg. F. or warmer. Cold material requires too much thinner to reduce it to working viscosity. Thinner added to cold material may cause separation of resin and pigment. If paint in drums is stored in a cold place, or received in cold weather, move to a warm room several days before using. If needed before the several days required for thorough warming, mix thoroughly, draw off as much as you need, and warm it to room temperature before using. Keep paints in containers as nearly airtight and as full as possible, or with a cover that drops down onto the paint surface. This prevents thickening by oxidation of oils and evaporation of thinner.

ORDERING—It is false economy to order material in larger quantities than can be used in a reasonable time. Don't order in 5-gal. lots unless 5 gal. can be used within one week, nor in drums unless 50 gal. can be used within a month.

STIRRING—Thorough stirring both before and after thinning is absolutely essential. All pigment that has settled must be loosened from the bottom and *thoroughly* mixed with remaining oil. Continue stirring until the paint has a smooth, even consistency. Stir frequently when left standing and always stir before any paint is taken from drum.

If container is too small or too full to avoid splashing during first mixing, pour off some top liquid, stir the rest thoroughly with a broad, flat paddle with a lifting, beating motion, then gradually add poured-off material, stirring all the time. Mix thoroughly every time paint is used. Incomplete stirring means paint too thin at the top and too thick at bottom, and a finish too glossy or too flat and off color. (Clear varnishes and lacquers contain no pigment and need no mixing before drawing from the original container.)

STRAINING—Paints containing specks, dirt and skins must be strained through a 40-mesh wire screen or through a double thickness of cheesecloth. New paint shouldn't need straining, but paint that has stood open for a short time may. Straining may be done either before or after thinning, but thinned paint passes through a strainer faster.

THINNING—Do not thin paints with oil, for paints are of proper mixture when purchased and need thinner only. Don't thin too much—get the right consistency. Stir thinner into paint slowly and thoroughly with a rotating and lifting paddle motion to raise heavier bottom material. If too much thinner is added at once, it will float on top and require longer to mix than if added slowly. It also may cause separation of resins and a gritty finish. Keep thin materials thoroughly stirred while in use, because the pigments have a greater tendency to settle out. Unless otherwise specified, thin paints to these viscosities (read with a No. 1 Demmler viscosimeter): Brushing, 80 sec. minimum; spraying, 50-60 sec. (pressure tank) or 20-30 sec. (suction cup); flowing, 15-30 sec.; dipping, 15-20 sec.

Add thinner from day to day to replace that evaporated, at the same time adding new paint and thinner to replace that used. When not in use, keep closed airtight. Equip portable spraying equipment with power-driven agitators; instruct operators of hand spray guns or users of open paint cans to stir thoroughly at least once an hour.

WHAT COLOR?—Choose trim colors that offer pleasing contrast to body colors, for example green window frames and white sash look better on a red-brick building than does red. Paint a concrete building in similar combinations instead of the usual gray, a wood building in proper combinations also. Outside structural steel surfaces, tanks, roofs, etc., can be made less conspicuous by finishing in light gray or aluminum rather than the usual black or red. Light colors also keep down temperature and reduce evaporation loss—of particular value on tanks containing volatile liquids. Many gas companies use a light gray for just that reason. Even under abnormal acid and alkali conditions, as in chemical plants, it isn't necessary to use dark colors any more.

Inside, keep ceilings as light and attractive as possible. Eggshell or gloss finishes are usually better and easier to clean. White is best, and next in order come ivory or light cream, then aluminum further down the line. New white finishes dry overnight, resist yellowing, hide well and are easy to keep clean.

Treat upper walls as you do the ceiling, to get maximum light reflection. The "dado"—from the floor to 4½ or 5 ft. up, should be darker contrasting color of high gloss and readily cleanable. Many plants use dark green or light or dark gray with white upper wall and ceiling. With ivory or cream ceiling, a dark brown, maroon or dark green is pleasing, and should be used also for trim, baseboards, etc.

It is becoming more and more popular to finish machines in other colors than black—shades of orange, yellow, green, gray and aluminum, with certain areas in contrasting color, for example. This increases visibility. Remember to use paints here that resist grease and oil, or heat, as necessary. Pipe-line identification with colors is now quite general in larger plants, and is coming along in smaller ones. Intricate systems of color identification have rather lost their vogue now, most plants having adopted simpler systems. These colors are painted only on valves and fittings, the line itself being painted to match the wall or ceiling nearest to it. A system of code letters with an arrow indicating direction of flow may also be used when piping begins to get complicated.

All this color betters appearance and improves housekeeping. This works toward better moralè and more uniform operation.

NON-METALLIC FINISHES FOR CENTRAL-STATION EQUIPMENT—The following six groups of finishes are listed in order of increasing durability and better appearance. In each group, the finish may be, in order of durability, a lacquer type, air-dried oil-type, or baked oil type finish. *Lacquer* is used when fast drying is required; cost is usually higher and durability lower. Spraying usually necessary. Drying time 15 to 30 min. per coat, primer 5 hr. *Oil type air-drying paint* is for general use, requires no special equipment, can be applied any way desired, durability not as good as baked finishes. Drying time 4 to 18 hr. *Baking finishes* give low cost on volume production and resist abrasion but require special equipment, hence are of little use in small-plant maintenance. Drying time 1 to 3 hr. per coat.

GROUP I—1-coat application (low cost, poor durability, medium appearance). Used mainly for color effects, to prevent tarnishing, and rusting on parts not outdoors. Tend to become brittle and chip off when old. Used on low-cost metal boxes, wood spacers, frames and clamps inside, concealed parts, etc.

GROUP II—2 coats, primed and finished (Increased adhesion and durability, medium appearance). Gives adhesion on brass and zinc and prevents spread of rust on steel parts subjected to moderate weathering. Cost about double that of Group I. Used on better grade cabinets, tanks, rotating apparatus.

GROUP III—2 coats of same material (improved duralibity. Medium appearance on rough surfaces, good on smooth surfaces). Gives better appearance on steel, resinoids, fiber and copper. Baked finishes fairly resistant to outdoor exposure. Cost double that of Group I. Applications are resinoid and switch parts, aluminum castings.

GROUP IV—3 or 4 coats (medium finish on rough or smooth surfaces). Filled and sanded finishes to give smooth surfaces on rough castings etc. Finish less smooth than Group V and somewhat cheaper. Used on switch-gear castings, mounting plates.

GROUP V—4 or 5 coats (High-grade finish, filled and sanded. Good durability). For rough surfaces. More expensive than earlier groups, used for castings requiring special appearance, brackets, metal boxes, cast brackets and machine bearings.

GROUP VI—3 coats outdoor finish (Highly durable, appearance medium). Inhibitive priming coat to retard spread of rust on sheet steel and cast iron. Cost about same as Group V. Used for outdoor tanks, structural steel frames, housings, marine metal boxes, resinoids for use outdoors.

These data abstracted from reports of Materials and Processes Engrg. and its Standards Dept., Westinghouse Electric & Mfg. Co., and an article by Roy E. Sheeler in the *DuPont Magazine* for September.

POWER SURVEY

Power and rate surveys started by the Federal Power Commission, 1933, will be able to continue through the allocation of $200,000 from PWA funds for this purpose. The money will enable the Commission to carry on the work until about Feb. 1, 1936, when Congress is expected to appropriate additional funds. Major points to be covered in the reports include: Characteristics of private companies and municipal utilities; sources of power; equitableness of rates among residential, rural, commercial and industrial customers, uniformity of rates, special rate contracts, etc. This information is collected by the Commission as part of its regular duties under the recent Holding Company Law, and will be of value in carrying out its duty of regulating intermediate power rates.

"I SUGGEST WE . . ."

By Ray Bar Glenn
Oakland, Cal.

Suggestions accepted by superiors have improved service and equipment protection and lowered inspection and maintenance costs

WHILE only a small percentage of suggestions are likely to be of direct value, executive consideration of those of apparently minor importance often leads to valuable ideas. Suggestions have made possible prompt and tactful correction of justifiable complaints, disclosed hazards to men and property, and have in many instances acted as a stimulus to carry vague or delayed plans to a definite termination.

In power plants, suggestions that will result in more economical generation and transmission, higher power factor, improvements in service by changed operating methods, better methods of protecting equipment, and lower costs for inspection and maintenance are of greatest value to the management. Obviously a well-balanced suggestion must not incur a hazard to service, equipment or workers.

Almost anyone can recollect valuable or interesting suggestions, yet a few examples will be mentioned. Before high-pressure lubrication became common practice the suggestion was made and applied to remove existing grease cups and force a more suitable grease into waterwheel-gate bearings under air pressure. The cost of this improvement was low. Better speed regulation due to more rapid gate movements, decreased power consumption by the governor-system pumps and decreased wear on turbine moving parts resulted. The suggestor was rewarded with advancement to a more desirable position.

In a hydro-electric plant where but one governor was employed to maintain system frequency, it was suggested that all eight governors be simultaneously employed for this purpose. This method of governing brought about improved speed regulation and a saving in water, since with all governors functioning the relief nozzles rarely opened. There was nothing novel in this suggestion, and its application involved no expense. Another ordinary suggestion was to apportion station load among the various generators to obtain highest plant efficiency. A noticeable saving soon became apparent.

In a plant where erosion of waterwheel buckets was unusually severe on dual-driven station auxiliaries, governor settings were changed so that the nozzles would remain closed except when speed was below normal. Application of this idea resulted in decreased maintenance costs and did not adversely effect plant efficiency or operation of auxiliaries. In a similar station where the practice of carrying the load on the waterwheels was continued, buckets wore through in one year.

Another simple suggestion that proved of considerable value was to make internal inspections of oil circuit breakers after a specified number of operations, as indicated on an automatic counter, instead of semi-annually, unless severe short-circuits were ruptured.

As might be expected, application of suggestions occasionally causes difficulties. In carrying out the suggestion to operate a turbo-generator as a synchronous condenser to improve power factor, steam was not kept flowing through the turbine. Windage caused excessive heating of the blading, finally evidenced by rubbing. Some of the blading required replacing. After this lesson, sufficient steam was admitted to prevent excessive blade temperatures.

Suggestions should always be presented in writing, when, as is generally the case, time permits. A written suggestion should invariably bear one's signature. When you prepare a suggestion, remember that it should at least bear evidence of careful thought based on sound principles. After considering all facts favoring and opposing it, decide if you would apply it were it in your power to do so. If you would, neatly and concisely translate your ideas through words, figures and sketches, if needed, into an intelligible report.

DIESEL or GASOLINE?

FACTS, not premises, on automotive diesel operating costs were reported Nov. 14 before the 16th Annual Meeting, American Petroleum Institute, at Los Angeles, by C. G. Anthony of Pacific Freight Lines, Los Angeles. The author's company operates 75 diesel and several hundred gasoline-driven trucks. From these, 20 identical heavy (68,000-lb. gross, with trailer) trucks were picked, ten diesel driven, ten gasoline driven. Variable cost figures were:

	Diesel	Gasoline
Average cost of fuel per gal.	$0.0383	$0.1216
Average cost of oil per gal.	$0.4618	$0.4727
Miles per gal of fuel	6.01	3.70
Miles per gal. of lube	144.1	160.5
Fuel cost per mile	$0.00638	$0.03947
Oil cost per mile	$0.00321	$0.00294
Repair cost per mile	$0.02148	$0.01689
Totals	$0.03107	$0.05930
Depreciation (200,000-mi. life, 10% junk value)	$0.02960	$0.02700
Interest (½ investment, 4 yr.)	$0.00396	$0.00366
Insurance (fire and theft)	$0.00067	$0.00061
Grand Total	$0.06530	$0.09057
Differential in favor of diesel	$0.02527	

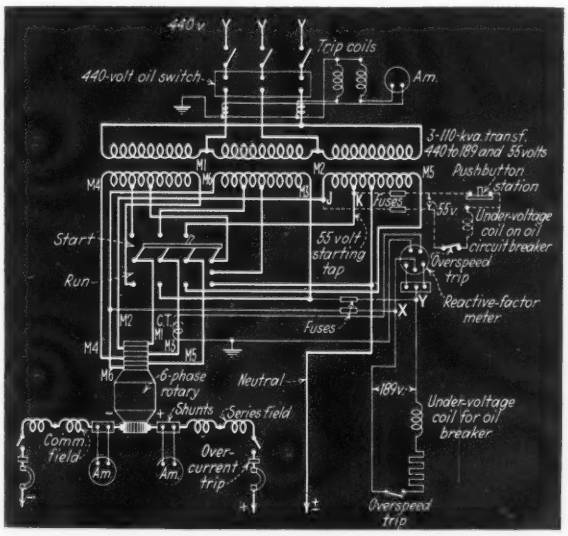
Mr. Anthony's company has found: 1. Diesel runs 60—65% further on a gallon of fuel. 2. Fuel cost per mile is over 6 times higher for gasoline engines. 3. Diesel uses more lubricating oil, and other costs are higher. 4. Apparently diesel repair costs are 25% higher, but this figure includes addition of new-design parts.

PRACTICAL AIDS TO OPERATION

Welding Generator Detects Plugged Conduit

WHEN concrete was poured in a large power-house recently, some conduits became plugged with cement. Since no one knew exactly where the pipes ran in the floors and walls, the problem was to locate the obstruction without digging up unnecessary parts of flooring or walls. The leads from a d.c. arc-welding set were connected to opposite ends of the clogged pipe. An ordinary compass was then passed up and down along the wall in which the pipe was imbedded. The change in direction of the compass needle as it passes the pipe makes it possible to draw a chalk line directly over each pipe in trouble. Then a fish tape was used to measure the distance from the ends to the plugged portion, making it possible to break out the concrete directly at the point of obstruction. The pipes were in some cases 14 in. below the surface, but half an inch or less deviation from the direct line could be detected by the compass needle.

East Pittsburgh, Pa. HENDLEY N. BLACKMON
Westinghouse Elec. & Mfg. Co.



Changes Connections to Correct Rotary-Converter Trouble

A 300-KW. rotary converter is started on 55-volt taps and, when up to speed, is thrown on full voltage, 189 volts. As originally connected, the alternating-current under-voltage coil was de-energized during the transition, which would cause the 440-volt oil switch to trip out at times, even when the tripping mechanism was held in by hand. This annoying trouble was eliminated by connecting the under-voltage coil through fuses to one of the three transformers.

The 400-ohm resistor, connected in series with the under-voltage coil, occasionally burned out. A resistor of greater rating could have been substituted, but removal of this source of trouble appeared to be the better plan. By testing it was found that 55 volts would cause normal current to flow through the relay coil. Accordingly the under-voltage coil was connected to one of the 55-volt taps. This change caused the under-voltage coil device to function at 70 per cent of the former voltage, a value not detrimental to the converter's operation. Originally the under-voltage relay was connected at *X* and *Y*. These connections were broken and connected to *J* and *K*, as in the diagram.

After several months it was found that the leads from the converter's transformers were saturated with oil. Investigation disclosed that some one with good intentions had insulated the originally bare sections in the leads above the oil level. It is standard and generally effective practice to prevent oil syphoning by baring transformer outlet leads above the oil level. After removal of the tape and soldering to fill the interstices between strands, oil leakage ceased.

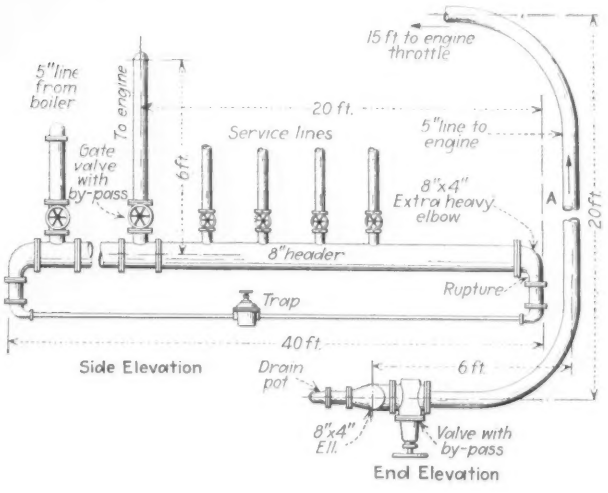
In order to save power by promptly stopping the rotary converter when direct current was not required, a circuit-opening push button was installed near a 90-hp. motor, to which the converter supplied power. This button was connected in series with the converter's under-voltage coil, as shown in the diagram, thus enabling the machine operator to trip the 440-volt oil switch. An electrician would then open the other switches at his convenience.

Oakland, Cal. RAY BARR GLENN

What Caused the Steam Header Fitting to Fail?

AFTER operation of a uniflow engine had been discontinued in a manufacturing plant it was the practice to run the engine under friction load for a short time each month to lubricate the cylinders and prevent rusting. The men who did this work were carefully instructed how to warm the engine and pipe line slowly and to handle the valves so as to drain the line of condensate, as would be done in the regular operation of the engine. After the engine had been started once a month in this way for about one year, a rather puzzling pipe failure occurred.

The steam-pipe system comprises a 40-ft. 8-in. header in the engine room, as in the figure. When the pipe failure occurred, one boiler was in operation and connected to the header by a 5-in. line. This boiler had about one-half glass



of water and was operating under light load. From the top of the manifold are taken several other lines, most of them going through reducing valves and to mill-heating units. All these lines are well insulated and properly valved and drained.

The 8-in. header is built of extra-heavy pipe and fittings and is connected at each end by reducing elbows to 4-in. condensate pots, which are drained through $\frac{3}{4}$-in. lines by a trap of ample size, known to have been working correctly when the failure occurred. A 5-in. pipe for the engine comes from the top of the header through a long-sweep bend, about 15 ft. of horizontal pipe and then through another long-speed bend down to the engine, as indicated in the figure. A gate valve with a small bypass in the line near the header was closed when the engine was shut down.

Before starting the engine the 5-in. line was warmed up and drained by opening the bypass valve, the engine drains opened and the throttle valve cracked. This should have thoroughly drained and warmed the line and engine, even if the system were full of cold water, which it most likely was not. After allowing the valves to remain this way for several minutes the gate valve was slightly cracked and allowed to stand in this position for awhile. Then, the valve was opened a little more and again allowed to stand, this operation being repeated until the valve was full open.

During this operation, before the failure occurred, there were no signs of distress or water hammer. Suddenly without warning one of the 8x4 in. reducing elbows on the header ruptured. Fortunately no one was seriously injured, even though two men were near the elbow when it failed and were in the path of the escaping water and steam.

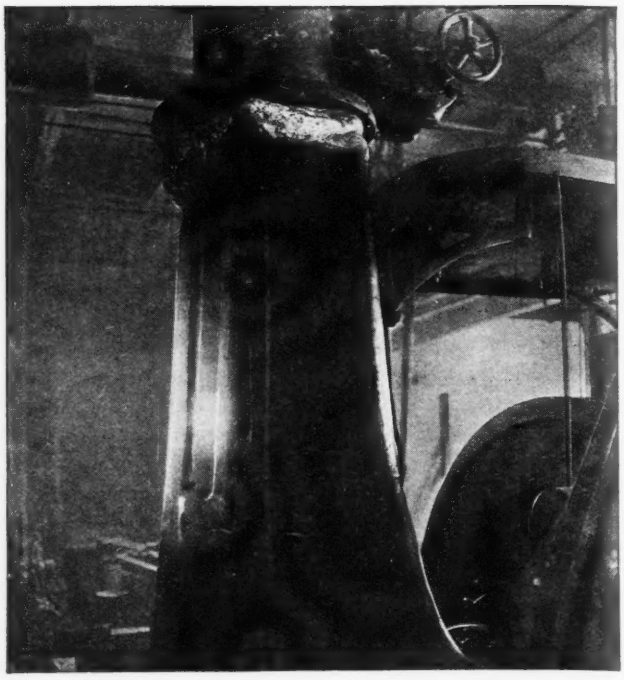
When examined, the break showed a slight flaw in the metal, but it appeared to be superficial. This fitting had a service record of 5 yr. under 175 lb. pressure, but failed when the pressure was only 100 lb. It, therefore, does not seem likely that weak metal or over pressure was the cause of the rupture. If any reader can explain when or how to avoid such a failure happening again, I would greatly appreciate having his advice.

Norwood, O. H. B. McDERMID

Old Compressor Repaired By Bronze-Welding

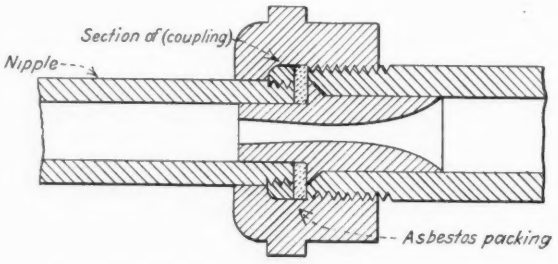
WATER got into one cylinder of a 30-yr.-old, twin-cylinder, single-acting ammonia compressor and broke the cast-iron cylinder support. This support is hollow, with a wall thickness of from 1 to 1.75 in. To avoid labor and expense for dismantling the unit for repairs, it was decided to use oxy-acetylene bronze-welding and do the work in place. When the fracture occurred, the parts separated $\frac{3}{16}$ in., and as connecting-rod length could not be adjusted it was necessary to bring the broken parts together. This was done by using 1 x 4-in. steel channels as levers, particular attention being given to lining up the parts.

Edges of the fracture were beveled 45 deg., making a 90-deg. vee. Two operators worked simultaneously on the job. While the welding was being done, the foreman checked the casting movement at various times to be sure that excessive distortion did not occur. It was found that the frame moved out of alignment about $\frac{3}{16}$ in. at the point where the blowpipe flame was applied, which checked up about right for this job. When the welding was finished, the casting was



allowed to cool slowly and evenly. When checked after cooling, the frame was found in good alignment. About 8 linear ft. of welding was necessary, which was done in 4.75 hr. and required about 26 lb. of 0.25-in. bronze welding rod and 1 lb. of Brazo flux. This welding job, shown in the figure, not only got the compressor back into service in a comparatively short time but also did so at a large saving in cost compared to other means of making the repair.

New York, N. Y. W. D. WILKINSON, JR., *Linde Air Products Co.*



Makes Flared Nipple From Pipe Coupling

A SHORT time ago, on a hurry-up job, I broke a badly rusted flared nipple on a steam jet while installing the latter. This nipple was made specially to fit the jet and as another was not readily available I decided to try making one. First I tried to make a duplicate by flaring one end of an ordinary pipe, but the pipe would not take the proper shape without cracking. The next attempt was to thread an ordinary pipe for a short distance. A short piece was then cut off a regular pipe coupling with a hacksaw, care being exercised to cut the pieces off squarely. This piece was screwed onto the threaded-pipe end until it was even with the pipe. The coupling-flare was then smoothed with a file to remove rough spots. After threading the other end of the nipple, the jet was assembled, as in the figure, with an asbestos washer between the nipple and jet to form a tight joint.

McCool, Miss. BUNYAN KENNEDY

Troubles Electro-Plating Generator Brushes

OVERLOADING brushes is a sure way to wear them out quickly, and to cause heating and sparking. This is particularly true of metal-graphite brushes used on electro-plating generators. One curious case of this kind shows how necessary it is to take nothing for granted when investigating brush troubles. The brushes of a large plating generator sparked excessively and wore out so fast that they had to be replaced every week or so. The machine was apparently overloaded, because the armature was hot all over with no sign of short-circuited armature coils. The plating-tank ammeters did not indicate that any excessive current was being taken. The fault was eventually traced to the wooden frames which supported the main busbars between the generator and the tanks. These frames, although apparently all right, were actually so soaked with acid that they practically short-circuited the busbars. The tank ammeters did not show this, and there was no main ammeter between generator and busbars to give the current reading.

Another case of plating-generator trouble showed excessive sparking and wear. The armature, although hot all over, did not seem to be overloaded. The machine had been neglected and was dirty. Metal-graphite dust had been allowed to accumulate into a mass against the heels of the brushes. As a result, the effective collecting area of the brushes had been increased across their toe-to-heel dimension, which caused too many commutator bars to be bridged at one time.

Low-voltage generators of the double commutator type are subject to a peculiar trouble. Unless both sets are set exactly at the proper neutral positions, one commutator tends to hog most of the load, and its brushes will spark badly. Adjusting the brush position will generally cure the trouble on that particular commutator. Since both windings are on a common armature, any variation of brush setting on one commutator may easily affect the neutral position of the other. Sparking may thus be started on the other commutator which did not spark before. The best way to cure this trouble is to take the load off one commutator and adjust its rocker; then to do the same with the other. Finally apply full load to both commutators, making final adjustments if necessary. With modern plating generators having interpoles, the last test is unnecessary, since the neutral position is fixed.

Cleveland, O.

L. L. STOFFEL
Chief Engineer
Ohio Carbon Co.

CURRENT COMMENT

New Sprayed Metal Data

THE following information on spraying molten metals has been developed from practical field experience and supplements material previously published in *Power*. It is necessary in ordering sand to be specific and state that a hard sharp flint or quartz sand is required, and that mesh size from No. 16 to 20 should be used, depending upon the character of work done and the depth of cutting effect desired. For general-purpose all-around blasting, No. 16 mesh is preferable.

The sizes of angular steel grit generally used for preparation of surfaces to be sprayed are No. 20 to 30 and 40, or mixtures of these sizes. For general blasting, when using a large pressure type blast machine and $\frac{1}{4}$ to $\frac{3}{8}$-in. blast nozzles, No. 20 angular steel grit is recommended. The larger sizes of grit serve to cut deeper abraded surfaces and produce a better bonding surface for sprayed metals. In use, the No. 20 angular grit shatters and is gradually broken up into the smaller sizes comparable with Nos. 30 and 40. Nos. 30 and 40 grit are used where blasted surfaces of a finer abrasion or cutting effect is desired, or where small blast machines with small openings in blast nozzles do not permit use of No. 20 grit.

The depth of blasting or projections raised by blasting have a considerable bearing on the bond strength or adhesion of sprayed coatings. As a rule, the softer, low-melting-point metals make a satisfactory bond on a fine blasted surface. However, there is no restriction or specific restriction against the use of deeper abrasions.

Bond strength will vary with the metals used, the rates of spraying or density of sprayed metals and character of blasted surfaces. Experience shows that published blasting rates—100 sq.ft. per hour for sand, 80 for No. 40 grit, and 50 for No. 30 grit—are impossible to attain and secure a properly roughened and cleaned surface suitable for metal spraying. Actual shop and field operation on blasting of large areas on ordinary tank steel or the equivalent shows that using an experienced operator with a large pressure blast machine with nozzles $\frac{1}{4}$ to $\frac{3}{8}$ in. I.D., and No. 20 angular steel grit, we can expect to blast from 20 to 30 sq.ft. per hour, securing a proper surface for metal-coating purposes.

New York, N. Y.

A. H. YOCH
Applied Engineering Dept.,
Air Reduction Sales Co.

The Operator Knows

I FIND myself in complete agreement with J. O. G. Gibbons in his item in October *Power*. It is refreshing indeed to find a consultant broadminded enough to admit that the humbler followers of Tubal Cain can aid him in his work.

Both consulting and operating engineers are vitally interested in one thing: plant betterment which will lower costs and, by so doing, safeguard their jobs. It is surprising how often humbler employees can contribute to this end. They are closer to the heart of plant operation and are able, quite often, to offer suggestions of real value.

Close cooperation between consultant and operator is most beneficial when new construction is under way. I stated in a previous article that it is good business for the employer, when building his plant, to engage his chief engineer at the very start of construction. He can readily spot defects or difficulties that are likely to arise in future, regular operation and get them corrected when such changes will not add to cost of construction.

An instance occurs on the same page as that of Mr. Gibbons' article. It is the "belt step" criticized by Mr. Kramer. An operating man would have seen this faulty setting of the valve at the time of installation, and correct placement would not have added to cost in any way.

Another instance I encountered recently will illustrate this. At a new plant all the $\frac{3}{8}$-in. piping for water cooling of bearings, and the slightly larger drain lines were made of iron. Had a practical operating man been on the job at the time of installation he, knowing water conditions, could have told them what actually did happen less than a year later. Scale and rust had clogged them all up. Since then all this piping has been replaced with brass, *but* the cost of piping, valves, fittings and labor has had to be charged again after only one year's service.

To sum up: even the most highly paid and highly trained college engineers can learn plenty from their humbler colleagues, but one rarely meets one who will admit it. I congratulate Mr. Gibbons.

Passaic, N. J. MARK BELL

Insulation of Cold Pipes

MR. BOHLINGER'S article in November *Power* on a non-sweating tank coating reminds me of a simple formula that will provide a very effective cold-pipe insulating coating at low cost. Whiting and raw linseed oil are mixed in the proportion of 5 lb. whiting to 1 gal. of raw linseed oil. About $\frac{1}{2}$ pint of dryer is added per gallon of oil. This mixture is painted thickly on surfaces to be covered. Next a supply of ground cork, mixed to the consistency of putty in the linseed-oil prepartion, is troweled on the pipe in a layer about $\frac{1}{2}$ to $\frac{3}{4}$ in. thick. When dry, the surfaces may be painted any desired color.

Brookline, Mass. HARRY M. SPRING

License the Diesel Engineer

HAVING some seventeen years' experience as a diesel power engineer, I would like to add comment to C. G. Robinson's article, "Should Engineers Have Federal Licenses?", in the September issue of *Power*. I agree with him. My hat is off to Mr. Robinson as the first engineer to go on record by expressing the need of inclusion of diesel engineers in the license laws. Had he served the long apprenticeship in diesel plants that I have, he would feel the need of a license law for diesel engineers as keenly as I.

To many of our readers the phrase "there ought to be a law" sounds rather hackneyed. We all agree that we have too many laws now—better to enforce the ones we have, rather than to pass new ones. That is what I now advocate —revise our old license-law structure and bring it up to date to cover at least two new fields for the operating engineer, air-conditioning and diesel engines. I can only speak from the diesel man's viewpoint, but in spite of this, the fact that an engineer chooses the diesel engine as his life work should not lessen his claim to the rights and privileges that are the due of his brothers in the steam-engineering field. Both types of plants have this in common: each requires a highly trained man to keep them running at top efficiency.

If such is not the case, then why do all shipping lines require their marine engineers, both steam and diesel, to be rigidly examined before being granted a "ticket"? Remember, the high-pressure boiler hazard is entirely lacking in a diesel installation. Why do all oil pipeline firms prefer to train their own engineers? The answer is that too much money is at stake to run the risk of putting poorly trained men at the "throttle." In the diesel field, the private plant owner, the superintendent of the electric-generating plant, and the industrial-plant operator has no such assurance that he is getting a certified man. More often than not, he must accept the engineer's own word for it or else a letter of reference from his previous employer. This letter may vouch for the man's honesty and ability to put out the work. Honesty and a willingness to work are essential, but they do not necessarily mean that the applicant has had special training and is well grounded in sound engineering principles.

I have found it all too often the case that the man ambitious enough to burn the midnight oil in his efforts to secure diesel education, is forced to compete with men far less capable than he and at the same rate of pay—for no other reason than that there is always some "monkey-wrench" mechanic around who imagines he has the makings of an engineer in him, and is, therefore, willing to work for less pay. The whole organization suffers, the plant suffers from a lowered maintenance standard, the owner suffers from increased repair bills—and the engines get the blame. It has been my experience that the difference between a bad engine and a good one is exactly the difference between a good engineer and one who is poorly or improperly trained and inexperienced.

Obviously the board of boiler inspectors would hardly be capable of passing on a diesel engineer's fitness any more than a diesel engineer would be capable of passing on a steam engineer's fitness. I suggest that one or two members of the board of examiners be steam engineers with diesel training. Many marine engineers have this training and I believe would be fully qualified to serve on the board. I believe that the matter of licensing diesel engineers is a movement worthy of serious consideration, and I should like to hear from other engineers in this field, through *Power's* pages.

Vero Beach, Fla. HOMER D. WHITE

Cutting in a Boiler

I DO NOT agree with Mr. Browning's method of cutting a boiler in with the pressure lower than the line pressure (*Power*, Oct., pages 542-543). If that is proper procedure, then the man that designed non-return valves for boilers made a big mistake, for you have to have some higher pressure in the boiler than in the header to raise the disk in the non-return valve.

I have seen the bonnet of an angle-valve raised $\frac{1}{8}$ in. from the body because the operator was in a hurry to get the boiler on the line, so cut it in before the pressure equalized. I would like to see this threshed out by experienced engineers. As for myself, I think the article is misleading to young firemen. I agree with Mr. Browning that an ounce of prevention is worth a ton of scrap.

Groveton, N. H. R. A. HAFFORD

THE ENGINEER'S BOOKSHELF

OIL AND GAS ENGINES, 1934-1935 (1935). *Publication No. C8 by Edison Electric Institute, 420 Lexington Ave., New York, N. Y. 19 pages. Price 50¢ to members and employees; non-members, $1.25.* — Discusses diesel engine progress and trends, diesel fuel oil, International Electrotechnical Commission work, high-speed engines, slow- and medium-speed diesels, miscellaneous cost data, plant operating data, etc.

SPECIFICATION AND TEST METHODS FOR COLD-SET CEMENTS (1935). *By S. M. Phelps. Published by American Refractories Institute, Pittsburgh, Pa. 8 pages, 6 x 9 in. Paper. Three photos. No price given.*—Presents tentative specification covering selection of mortars for clay refractories for boiler furnaces and incinerators.

MONEL METAL CASTINGS (1935). *Published by International Nickel Co., Inc., 67 Wall St., New York, N. Y. No price given.*—Contains information on properties of Monel metal castings, particularly special 2½% Silicon Monel metal and "S" Monel.

METAL CLEANING HANDBOOK (1935). *By Robert W. Mitchell. Published by Magnus Chemical Co., 161 South Ave., Garwood, N. J. 216 pages, 6 x 9½ in. Extensively illustrated. Free to users of metal cleaning. Price $1 to others.*—Describes equipment, methods and materials for metal-cleaning, with practical suggestions for use.

JS-DIAGRAMS FOR COMBUSTION GASES OF CORRECT AND WEAK MIXTURES (1935). *By Keikichi Tanaka and Seiichi Awano. Published by Kôku-Kenkyuzyo (Aeronautical Research Institute) of Tokyo Imperial University, Komaba, Tokyo, Japan. No price given.*—Paper contains eight sheets of total heat entropy diagrams for combustion gases of correct and weak mixtures, besides some auxiliary diagrams for use with internal combustion engines, especially gasoline.

HYDRAULIC LABORATORIES IN THE UNITED STATES (1935). *Published as Hydraulic Laboratory Bulletin, Series B, by National Bureau of Standards, Washington, D. C. 91 mineographed pages, 8 x 10½ in. Paper. No price given.*—Lists and gives complete descriptions of 53 hydraulic laboratories in the United States.

SILENT CHAIN DRIVE SELECTOR (1935). *Published by Morse Chain Co., Ithaca, N. Y. Free to users.*—Similiar to slide rule, device simplifies selection of chain driver of ½ to 150 hp. Selects number of teeth, pitch, width of chain, standard center distance, etc.

WHAT ABOUT DIRECT LOANS TO INDUSTRY? (1935). *Prepared by Committee on Direct Loans of National Conference of Business Paper Editors and Associated Business Papers, Inc., 330 West 42nd St., New York, N. Y. 34 pages. Price 50 cents.*—No. 5 of series of analytical studies dealing with current national questions of business interest.

AIR CONDITIONING (1935). *Publication No. C7, by Edison Electric Institute, 420 Lexington Ave., New York, N. Y. 24 pages. Price, 50 cents to members and employees; non-members, $1.25.*—Contains data on typical air-conditioning installations. Size and character of equipment and purpose to be achieved in each installation is given, together with hours of operation, maximum demands, energy consumption and other factual data. Statements from manufacturers on cooperation which public utilities can render in promoting use of air-conditioning equipment.

VARIABLES IN COAL SAMPLING (1935). *By J. D. Morrow and C. P. Proctor. Published by American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York, N. Y. 45 pages, 34 tables. Technical Publication No. 645, Class F, Coal Division, No. 67.*—Factors and problems encountered in coal sampling.

DAMPFKESSELSCHADEN *(Defects of Steam Boilers)* 1935. *By Ernst Pfleiderer, 259 pages, 244 illustrations. Published by Julius Springer, Berlin, W. 9. Price, 24 reichmark.*—Cause and prevention of boiler defects and application of this knowledge for further development. Takes up successively characteristics of materials, precautions to be observed in their production, and considerations to be taken into account in the design, manufacture and operation of the boiler. These include such items as stresses at rivet holes, various types of welding, stresses and possible crack-formation due to the expanding of tubes into shells, corrosion, oil in boiler water, etc.

LEFAX SHEETS (1935). *Two sheets, Nos. 35-23 and 14-46, respectively, on Wiring Installation Design and Conductors for Wiring, published by Lefax, Inc., Philadelphia, Pa.*—Taken from National Electric Code of National Board of Fire Underwriters, effective November 1, 1933.

MULTIPLE RETORT GRAVITY-UNDERFEED STOKER (1935). *By W. M. Dodds. Published by Fuel Journals, Ltd., Hazlitt House Southampton Buildings, Chancery Lane, London, W. C. 2. 48 pages, 5½ x 8½ in. Paper. 25 illustrations, 5 tables. Price not given.*—Embodying a paper presented before the Electrical Power Engineers Association; describing some modern foreign installations of multiple-retort "Taylor" gravity-underfeed stokers. Presents performance figures, recent development, future designs and operation, and, in appendix, history since 1903.

SMOKE PREVENTION (1935).—Number of papers presented at the 1935 session of the Smoke Prevention Association include "Packaged Fuel," "Modernization of Boiler Furnaces for Increased Combustion," "Removing Solids from Chimney Discharges," "Railroad Locomotive Operating Data," "Oil vs. Coal," "Importance of Equipment in Smoke Abatement Work," and "Automatic Coal Stokers in Smoke Abatement." Also a paper presented by the Chicago Smoke Department covering "Air Pollution Caused by Use of High Sulphur Coals."

SYDNEY, NEW SOUTH WALES, ANNUAL REPORT OF THE GENERAL MANAGER OF THE ELECTRICITY DEPARTMENT FOR 1934 (1935). *76 pages, 8¼ x 13¾ in., paper. Many charts and tables.*—Elaborate and comprehensive report gives every detail included in general, commercial and technical phases of electricity supply undertaking started in 1910.

COMBUSTION (1935). *Report of the Combustion Subcommittee of the Prime Movers Committee, Edison Electric Institute. Publication No. C6 by the Institute, 420 Lexington Ave., New York, N. Y. Price, 80 cents to members and employees, $2 to non-members.*—Contains statements by subcommittee, operating companies and manufacturers on combustion of oil and gas fuels, control, furnaces (other than pressure parts of water-cooled furnaces), stokers, ash and dust elimination and ash disposal, mechanical draft equipment, pulverizers and pulverized fuel.

EQUIPMENT AND MACHINERY ELIGIBLE FOR MODERNIZATION CREDIT INSURED BY THE FEDERAL HOUSING ADMINISTRATION (1935). *Published by FHA, Washington, D. C. Bulletin No. FHA-145.*—26-page booklet contains an amplification of statement of basic policy contained in Regulations No. 7 and No. 24 of Amended Modernization Credit Plan, published July 15, 1935, regarding the eligibility of property improvement and of equipment and machinery which may be financed on insured loans.

MECHANICAL CATALOG, 1935-36 (1935). *25th annual volume published by American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y. 338 pages, 8¼x 11¼ in. Issued free to members on request.*—Contains descriptions of 1,500 items and lists 700 firms.

GENERAL HARBOUR (SAFE-WORKING LOAD) REGULATIONS, 1935 (1935). *Published by Marine Department, Wellington, New Zealand, 80 pages, 6x9 in., paper. Many diagrams, tables and charts. Price, 1 shilling.*

REPORT OF COMMITTEE ON SHOP POLICY (1935). *Published by Armour Institute of Technology, Chicago, Ill. 26 pages, 6x9 in. Paper. Many charts and tables. No price given.*—Gives results of investigations made by committee to determine shop policy for Armour Institute.

CLASSIFICATION AND SELECTION OF ILLINOIS COALS (1935). *By G. H. Cady. Bulletin 62, published by Illinois State Geological Survey, Urbana, Ill. Price, $1.*—Includes method of selection based on system of classification recently adopted for North American coals by A.S.T.M. and compilation of analyses of face samples of Illinois coals with mine and county averages, and reproductions of three nomographs for determining heat value of "coal as received," based on values from tables.

SUPPLY AND DISTRIBUTION OF COAL IN CANADA (1935). *Published by Dominion Fuel Board, printed at Office of Surveyor-General, Ottawa, Canada.*—5-color charts showing supply and distribution of coal in Canada, also importations from United States, Great Britain and other countries.

READERS' PROBLEMS

QUESTIONS for Our Readers

Replacing Piston Rings

Question 1

WHEN *is it advisable to replace piston rings in diesels, gas engines, and compressors? I would like to have some sort of practical yardstick for measuring the proper interval between ring replacements.*—C.R.L.

Float-Governed Feedwater

Question 2

WE OPERATE *four boilers, and it has been suggested that we connect each boiler drum below the waterline to a 4-in. header and connect this header in turn to a standpipe or drum in which is arranged a float. Of course, a connection will also be made from this standpipe to the steam space of each boiler to equalize the pressure. The float will be used to control the throttle on our feed pump and so always maintain a proper water level. The suggestion does not seem good to me, but I should like to have* POWER *readers tell me what troubles will be likely to occur.*
—W.H.T.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

Amortisseur Winding

I HAVE *seen the words "Amortisseur Winding" appear in engineering literature on several occasions, but have been unable to find a definition of these words. What kind of a winding is this and where is it used?*
—A.C.L.

Amortisseur windings and damping windings are placed in the pole faces of alternating-current generators, rotary converters and synchronous motors to prevent hunting. In synchronous motors, these windings serve a double purpose. During starting they act as starting windings and during running stabilize the machine to prevent hunting. These windings are usually of the built-up type commonly employed on the rotors of induction motors, consisting of bars in slots in the pole face and connected on the ends by continuous rings. A cast copper damper winding is sometimes employed, consisting of relatively few bars of large cross-section in the pole faces. In commutating-pole converters, the end rings are sometimes made in disconnected segments, one for each pole, so that the commutating poles will not be enclosed by the damper winding.

Pulverized Coal Burned

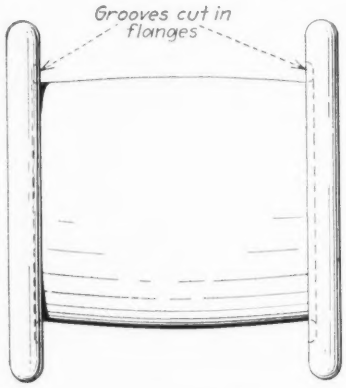
HOW *much coal was burned by pulverized-fuel installations in 1934? Can I find lists of these installations?*—J.N.

There is no information available on the amount of pulverized fuel used in the United States during 1934. There is no statistical agency which collects this data, the only thing approximating it being the Dept. of Commerce reports which show central-station production of electricity with various types of fuel. This, however, breaks the classification down only into coal, oil, gas, wood and hydro. You might get some idea, however, as to the relative numbers and sizes of pulverized-fuel installations by checking the lists of new steam plants published in *Power* each January, and in the rather elaborate tables which appeared in our June, 1934, number. These will also give a representative list of plants.

How to Keep Belts from Climbing Pulley Flanges

WE HAVE *a flat-belt running on flanged pulleys. This belt has a tendency to climb up on the flanges on one side of the pulleys. How can this be prevented?*—R.C.M.

First make sure that the pulleys are in line and their shafts level. If this does not correct the trouble, the belt may be crooked and should be rebuilt or replaced. If the belt must be used, turning a shallow groove in the flanges at the pulley face, as in the figure, will keep it from climbing the flanges. The groove should be slightly wider than the belt is thick.



CLEANING OIL FROM PIPING

ANSWERS to October Question No. 1

The Question

WE HAVE *recently modernized our plant, replacing old steam engines with turbines. The steam engines exhausted against back-pressure to process, but the condensate was not used for boiler feed because of oil carried over in the engine exhaust. The new turbines also exhaust to process through the old piping system, and we find we are still unable to use the condensate because of oil that has collected in the old exhaust lines. Is there any way that we can clean out this piping so that we may use the returns for boiler feed and so greatly reduce our makeup water, which is now running about 60%?*—G.S.R.

Circulate Caustic-Soda Solution With a Pump

THE problem of cleaning oil from a piping system is important. Oil in returns to a feedwater system will cause serious trouble in steam boilers, and all traces of such oil should be removed. I believe the most practical way to purge the system of oil deposits is to secure a small motor driven centrifugal pump. This pump should be connected up temporarily, so as to provide forced circulation through the system. Next, the system should be filled with a solution made by dissolving about 75 lb. of caustic soda per thousand gallons of water capacity in the entire system. If there is any practical way to externally heat the solution at the pump discharge, it should be done, as it will make the treatment more effective and shorten the necessary time.

With a cold solution, forced circulation should be continued for about 24 hr. This time may be decreased about 25% with a hot solution. At the end of this period the system should be drained and thoroughly flushed out several times with clean water.

If any traces of oil still show in the returns, the treatment described should be repeated. This method will result in removal of oil deposit, and also of most rust and scale in the system.

Brookline, Mass. HARRY M. SPRING

Caustic Soda Used To Remove Oil from Condenser

I HAVE known of similar conditions obtaining in surface condensers and on the tubes of condensers of vacuum pumps in wet-vacuum systems serving extracting, condensing turbines wherein the oily accumulations came

from the cylinder oil used for internal lubrication of the extraction-valve mechanism. Not only was there the attendant difficulty of oily boiler feedwater (as the condensate was returned as make-up to the boiler room) but it also decreased heat-transfer within the condensers, causing faulty vacuum, which resulted, of course, in uneconomical operation of the units.

To remedy this trouble a handhole plate was removed from the main condenser and a liberal quantity of caustic soda, NaOH, was poured inside the shell, around the tubes. The plate was then replaced and a connection was made to the bypass of a convenient steam trap (this was only a ½-in. line equipped with a globe valve for throttlnig purposes, as only a very small amount of steam was required). Then the condenser shell was completely filled with water by means of a condensate make-up raw-water connection in the hot-well. The solution was allowed to boil for about 4 hr. and it was then pumped out through the condensate lines by the condensate pump. The solution, together with a liberal amount of rinsing water, was emptied into the sewer. This cleaned away the oil deposits satisfactorily, and judicious application of the lubricant afterwards prevented its reappearance.

Kingsport, Tenn. BENJAMIN E. LINGAR

Use Solvent Vapor

BOTH soda ash and caustic soda have been used to remove oil, but generally do not do a very thorough job. To be successful, the solution should circulate over the surface at fairly high velocity.

Any of the oil solvents will generally remove oil deposits more thoroughly than either soda ash or caustic soda, but in the case of a piping system of any size, the amount required to flush out the piping would be so great that cost would prohibit their use.

In the metal industries oil has been successfully removed from surfaces by placing the surface so that vapor from a solvent condenses on it. As the condensed solvent vapor runs off, it carries the oil with it in solution. The condensed solvent runs back to the vaporizing equipment and is used over and over again. It may be possible to adopt this principle to the removal of oil from your steam line.

To apply this your exhaust steam line should be well pitched so that condensed solvent will drain quickly to a low point. The solvent vaporizer may be conveniently located at this point to avoid a long return line.

It would be best to use a non-inflammable solvent with a relatively low boiling point such as dichloroethylene which boils at about 99 deg. The low boiling point will help in forcing the vapor throughout the length of the exhaust line. If the line is very long it may be necessary to raise the pressure of the vapor or to exhaust air from the line at the opposite end with a fan.

New York, N. Y. P. R. BROCKNER

WHEN TO RENEW ROPE ON HOISTS AND ELEVATORS

ANSWERS to October Question No. 2

The Question

WE HAVE *several hoists and elevators in our plant. After considerable discussion among our plant operators we have not arrived at a satisfactory answer to the question: How frequently should the ropes on these equipments be inspected? What is a reasonable length of service for these ropes? What is the best method for determining when the ropes should be renewed? Will some readers of* POWER *give us the benefit of their experience in solving these problems?*—K.B.T.

Emphasizes the Need for Careful Inspection

FEW items of common equipment in any plant hold such potential danger to human life and limb as do elevators and hoists. For this reason, the responsibility for maintaining elevators in an absolutely safe condition is very serious. The average plant mechanic, no matter how conscientious and skilled, should not be depended upon to handle complete maintenance of elevators or to judge their mechanical condition.

The useful life of cables and other vital parts of elevators depends upon a number of variables, such as amount of usage, hoisting speed, loading conditions, presence of abrasive dust or corrosive fumes, etc. It is impossible, therefore, to establish any general rule for either equipment life or frequency of inspection. Elevator maintenance and inspection schedules should be based on local conditions in each plant and recommendations by the equipment manufacturer. A liberal inspection schedule should be observed, as this will minimize hazards and prevent annoying and sometimes costly interruptions of service.

Unless a plant is large enough to justify continuous employment of an elevator expert, the best policy for the plant owner is to maintain a service contract with a reputable firm of elevator specialists. Such contracts are available in various forms, covering any service from complete maintenance down to periodic inspections. With a type of contract adapted to his particular requirements, the plant owner may feel assured that his elevators are receiving the attention of qualified experts at regular intervals and that incipient defects will be discovered in time to prevent serious consequences.

Old Bridge, N. J. A. J. LUBELEY
Chief Engineer,
Anheuser-Busch, Inc.

Gives Factors That Influence Rope Life

THE service and duty of elevators and hoists influence the frequency of inspection and rope replacements. For severe service, rope inspection should be made daily. Where service is continuous and average loads handled are reasonable, weekly inspections will suffice.

So many factors influence the life of wire rope that it is difficult to predict a reasonable length of service for any particular installation. It may be a few months or several years. Some of the principal factors affecting length of service are: Time under load, amount of swinging, atmospheric and temperature conditions, lubrication, ratio of drum to rope diameter, method of roping and number of bends in rope, factor of safety of original rope, condition of sheaves, and methods of starting and stopping.

Determination of when ropes should be replaced must depend upon their general condition. Factors that determine the ultimate life, in order of their importance, are: broken wires, wear of wires, corrosion of wires, reduction in diameter of cable, and fatigue of metal in wires. A safe rule to follow is to condemn a rope when six wires are broken in one strand lay. Use of this rule, combined with sound judgment, will get about all the service a rope can give.

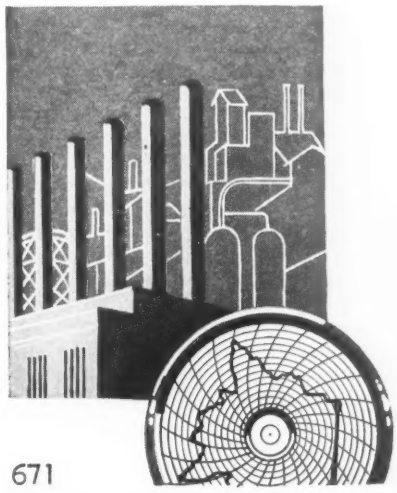
There is no way of determining the detrimental effects of corrosion on a rope; it must be left to the inspectors' judgment. External corrosion may be readily detected and its effects estimated, while internal corrosion is obviously difficult to detect. Proper lubrication helps prevent both.

Reduction in rope diameter may be due to excessive wear, corrosion, or collapse of the hemp core. The latter may occur where ropes are subjected to high temperatures for long periods. The heat chars and deteriorates the hemp center, then the outer strands collapse.

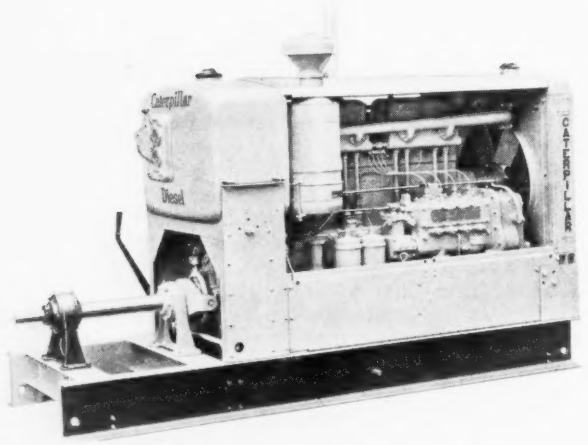
Fatigue of the metal is indicated when a rope starts suddenly to show broken wires, rapidly increasing in number with little or no signs of wear. When fatigue sets in, ropes should be carefully watched, and if deterioration is extremely rapid they should be replaced.

Aside from the reduced strength indicated by broken wires and wear, whether a cable should be condemned or kept in service must rest largely upon the ability of the inspector to evaluate the various other injurious factors that may be present. It is always important to make a careful inspection of all rope fastenings, such as clips, clamps and sockets for broken wires, tightness and to prevent ropes from pulling out.

St. Mary's, Ohio J. L. YOUNG



WHAT'S NEW IN PLANT EQUIPMENT



THREE 4-CYCLE DIESEL POWER UNITS

CATERPILLAR has redesigned its 75, 50 and 40 power units for greater power, now offering D13000 (125 b.hp. max., 95 b.hp. continuous duty), D8800 (77 b.hp. max., 59 b.hp. C.D.), and D6100 (47 b.hp. max., 37 b.hp. C.D.). All are 4-cycle, gasoline-engine started, $5\frac{3}{4}$ x 8 in., 850 r.p.m., with 6, 4 and 3 cylinders respectively. Force-feed lubrication. Individual fuel pumps and improved injection system. Steel channel base. Cylinder liners heat-treated, chrome-nickel cast iron. Fourth model to be offered soon will be 4-cyl., $4\frac{1}{2}$ x $5\frac{1}{2}$-in. 1,400 r.p.m. unit with 2-cyl. opposed-piston horizontal gasoline starting engine mounted at rear. Engine cooling systems tied together, so warmed gasoline jacket water speeds warming of diesel. Bulletin Form 1823-33-C for D13000, Form 1823-31-C for D8800, and Form 1823-29-A for D6100. Larger illustration shows D13000 from fuel pump side; smaller shows D6100 starting-engine detail.

Caterpillar Tractor Co., Peoria, Ill.

BRAKE LINING

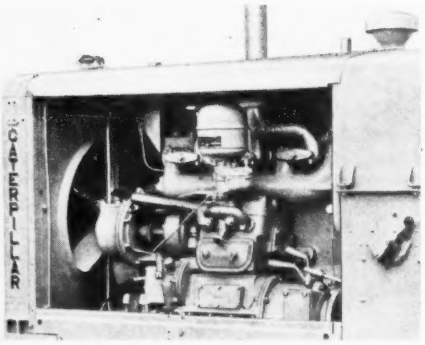
THERMOID BX woven brake lining for use on heavy industrial machinery and equipment, has asbestos tape base woven in single thickness. Tape is woven of heavy yarn containing brass wire and impregnated with highly resistant Bakelite rosin. Said to have high coefficient of friction and ability to stand heat above 900 deg. F., in presence of oil, grease or water.

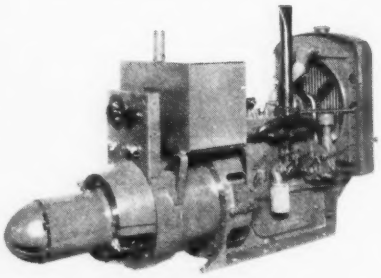
Thermoid Rubber Co., Trenton, N. J.

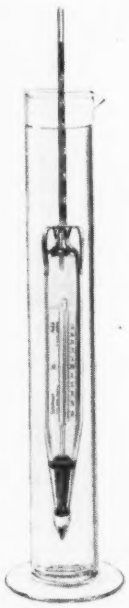
HYDROMETER

FOR control of boiler salines and other applications, automatic compensating hydrometer, "Pacometer," calibrated for quick reading at either high- or low-temperature ranges, has self-contained thermometric correction scale in bulb. Stem made of strip about $\frac{1}{4}$ in. wide of highly polished metal, with scale readings etched on surface. Metal stem attached to glass bulb by two sets of spring prongs readily detached for cleaning. Bulletin No. 498.

Permutit Co., 330 West 42nd St., New York, N. Y.







ENGINE-DRIVEN WELDER

"200-AMP., Shield Arc Special" welder for welding with bare or heavily coated shield-arc electrodes in all sizes up to $\frac{1}{4}$ in. Current range from 60 to 250 amp. Single-operator, variable-voltage type generator with completely laminated magnetic circuit and interpoles. Both series and shunt fields adjustable. Shunt field excitation supplied by exciter connected on generator end of unit. Power derived from Waukesha 4-cyl. 23-hp., 1,400-r.p.m. engine, with gear-driven governor, high-tension magneto, vertical carburetor and air cleaner.

Lincoln Electric Co., Cleveland, Ohio.

TRANSMISSION BELT

CORDS embedded in rubber and square cut edges. Laminated and cut edge construction permits use of single ply of duck on each side. Widths to 24 in., and plies from 5 up.

U. S. Rubber Products, Inc., Mechanical Goods Division, 1790 Broadway, New York, N. Y.

DIESEL FUEL FILTER

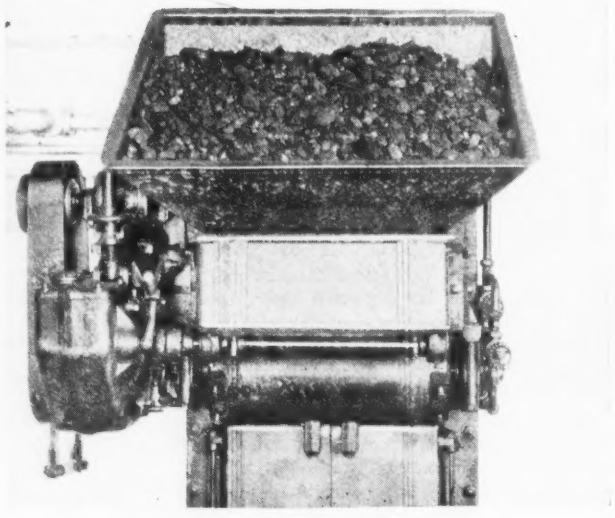
D-23JWM-1, "Purolator" made up of two units; first, where accumulation of dirt is more rapid, uses knife-cleaning metal element; second has woolen fabric element with metal element inside. Tapped for $\frac{1}{4}$-in. iron pipe, capacity 4.45 g.p.m., over-all height, $9\frac{5}{8}$ in. Diameter of case, $2\frac{7}{8}$ in. Weighs 9 lb., 8 oz.

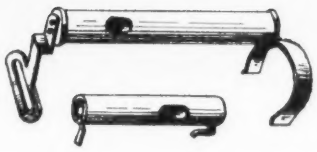
Motor Improvements, Inc., 365 Frelinghuysen Ave., Newark, N. J.

STOKER

DESIGNED to burn all types and grades of coal, this stoker has over-running rotor of solid cast-iron segments. Coal fed to rotor by large, slow-speed, reciprocating feeder shoe. Movable gates which determine height of fuel bed are pivoted to allow passage of tramp iron, etc. Eccentric gears and variable feed controls sealed in case and submerged in oil. Outboard, water-cooled, grease-packed, self-aligning ball bearings on rotor. Entire frame water-cooled. Made in one or two parts. Feed plate of $\frac{1}{4}$-in. steel slides in guides in stoker frame. Bulletin.

Wm. Bros Boiler & Mfg. Co., Minneapolis, Minn.





BLOWN-FUSE INDICATORS

TYPE *B* blown-fuse indicators for use with ferrule or knife-blade, single- and double-throw switches on 110- to 600-volt circuits up to 600 amp., show reddish glow when fuse blows. Small sizes slip over fuse clips while larger sizes are attached to fuse. Fuse knife blade slips through slot on one end, bronze spring clips clip on other end of fuse. Indicator is on side, out of way of switch handle. Not injured by ordinary short-circuit overloads.

F. C. LaMar Indicating Fuse Corp., Chrysler Bldg., New York, N. Y.

FINISHES

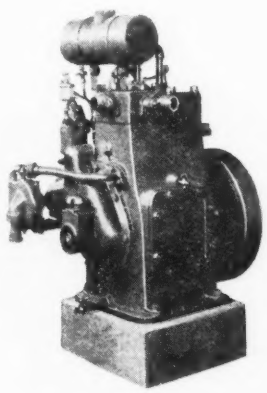
FILMS with base of vegetable gums and heat-treated oils said to be non-porous and impervious to water and corrosive atmospheric gases. Applicable to wood, dry concrete, plaster, etc. Primers with non-porous base available. Applied by brushing, spraying or dipping, after thinning. Drying time 4 to 16 hr.

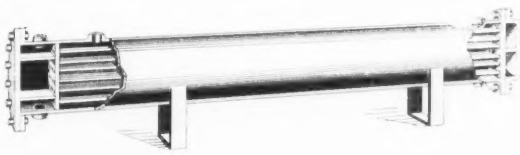
Technical Coatings, Inc., 9-15 Park Place, New York, N. Y.

DIESEL AND GAS ENGINE STARTER

SINGLE-STAGE air compressor for starting gas and diesel engines said to be capable of filling 6 cu.ft. tank to 200 lb. pressure in 5 min., or 250 lb. in 9½ min. Known as GX3A, uses either gas or gasoline. Ford pistons, piston rings, connecting rods, connecting-rod bearings, engine valves, and many smaller parts are used, Power and compressor cylinders cast in one piece are water-jacketed. Automotive-type power-cylinder head, separate casting, is water-cooled and carries spark plug only. Ford Model B gasoline carburetor, adjustable gas-mixing valve and rotary-type magneto with impulse coupling are standard equipment. Bulletin No. 110.

Cooper-Bessemer Corp., Mt. Vernon, Ohio.





FUEL OIL HEATERS

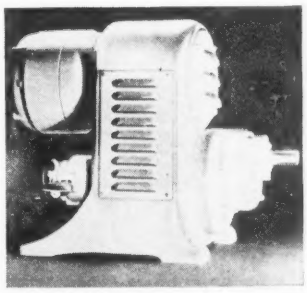
TO REDUCE viscosity of fuel oil by heating before burning, these heaters use live steam at boiler pressure. For either vertical or horizontal operation. Straight-tube, multi-pass design, with shell, tube and tube sheets of steel, and rear head casting of semi-steel. Steel oil chamber formed by extension of shell. Tube sheet at rear end welded to shell. Rear head casting bolted with through bolts to tube sheet. Both ends of tubes expanded into tube sheet with roller expanders, and any tube may be removed without disturbing others. Catalog section No. 801.

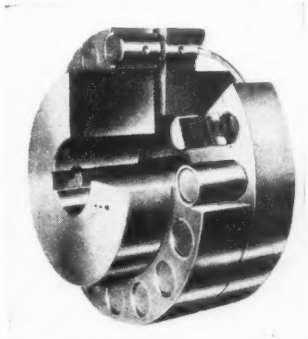
Patterson-Kelley Co., East Stroudsburgh, Pa.

VARIABLE-SPEED DRIVE

TO SAVE lateral space and enable user to have take-off shaft at either high or low position, "U. S. Varidrive" is now offered in upright design.

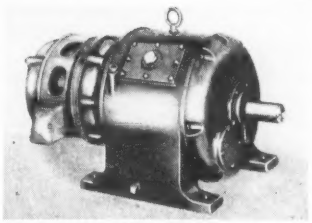
U. S. Electrical Mfg. Co., 200 E. Slauson Ave., Los Angeles, Calif.





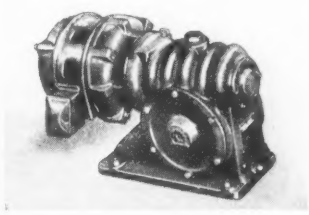
GEAR MOTORS

HELICAL and worm-gear motors and speed reducers either direct-connected or coupled types in single, double and triple reductions for horizontal, vertical or right-angle drives. Motors on double and triple reduction units are supported on gear case.



Available with all types of motors. "IXL" helical gear motors adopted to drives which require ¾ to 75 hp. and speeds down to 6 r.p.m. from 1,750 r.p.m. motors. Lower speeds by using lower-speed motors. Units equipped with heat-treated chrome-nickel-steel gears. Efficiency of double-reduction units said to be 96%, and of triple-reduction units, approximately 94%.

"IXL" worm gear motors in power capacities from ¾-hp. to 40-hp., with speeds down to 30 r.p.m. with 1,750-r.p.m. motors, said to be 95% efficient at low



ratios. Worms high-carbon alloy steel integral with shaft. Worm gears are hobbed with involute tooth forms from chilled cast bronze. Bulletin No. 1870.

Diehl Mfg. Co., Elizabethport, N. J.

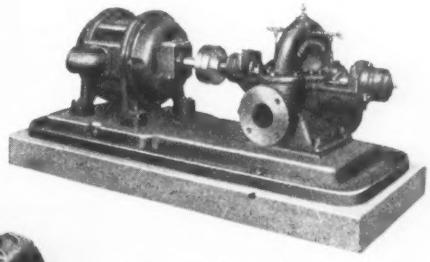
FLEXIBLE COUPLINGS

FORGED, high-manganese, alloy-steel for smaller sizes, while larger sizes of "Francke" flexible couplings are cast of semi-steel. Bushings have highly polished bearing surfaces, with self-lubricating, wax-impregnated bronze bushing. Center portions of crosspins which pass through perforations in laminations made glass hard, and ends of crosspins expanded into tapered recesses of keepers.

John Waldron Corp., New Brunswick, N. J.

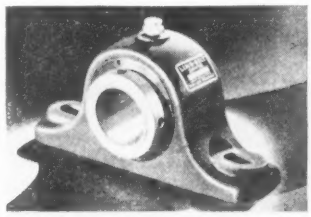
CENTRIFUGAL PUMPS

DOUBLE-SUCTION, single-stage, sleeve-bearing centrifugal pump, Classes SHD, SMD and SLD, has



horizontally split casing with both suction and discharge openings in lower half. In larger sizes, balancing port cast in lower casing connects two suction chambers at impeller inlet. Bronze double-suction inclosed-type impeller is attached to shaft by shoulder and jam nut and keyed with Woodruff key. Renewable casing wearing ring is held in pump by double shoulder in lower half, and single shoulder in upper half. Shaft is alloy stainless steel, heat treated, and ground with taper for mounting flexible coupling. Pump direct-connected to prime mover by flexible pin-and-rubber buffer coupling on cast-iron baseplate. Bulletin No. 224.

Pennsylvania Pump & Compressor Co., Easton, Pa.



ROLLER BEARING

SHAFER self-aligning roller bearing unit, "Series 400," uses self-aligning double-row roller bearings with concave rollers between convex outer races and spherical inner race on sleeve, free to deflect with shaft out of line temporarily or because of inaccurate installation. Bores are ground for direct shaft application. Book No. 1494.

Link-Belt Co., 300 West Pershing Road, Chicago, Ill.

UNIT HEATERS

SEVEN sizes have been added to line of Series 3 unit heaters to provide sizes and capacities up to 1,300 EDR. Data Book No. 537.

Fedders Mfg. Co., Buffalo, N. Y.

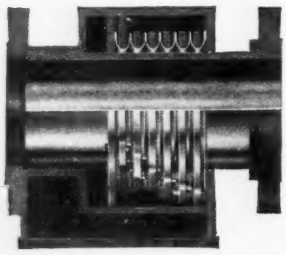
UNIT HEATERS

FOUR models added to "Modine" unit heater line feature "direct-from-steam-pipe-suspension" installation. Expansion-bend allows individual expansion of each or separate tubes. Catalog No. 635.

Modine Mfg. Co., Racine, Wis.

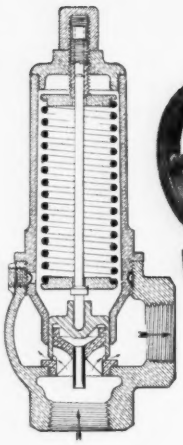
EXPANSION JOINT

U-RING type, pipeless expansion joint for controlling expansion in steam and hot-water lines, etc., has expansion element formed of series of die-formed "U-Rings" of stainless alloy steel welded together without transverse seams. One end is welded to wrought-



steel body of joint and at opposite end to a plate that is in turn welded to sleeve. Guarded at three points to permit sleeve to move freely without binding. Wrought-steel body encloses expansion element. Available for pressures to 400 lb., temperatures to 800 deg., with flanged ends or beveled ends for welding directly into pipeline with or without anchor base. Bulletin No. 35-50.

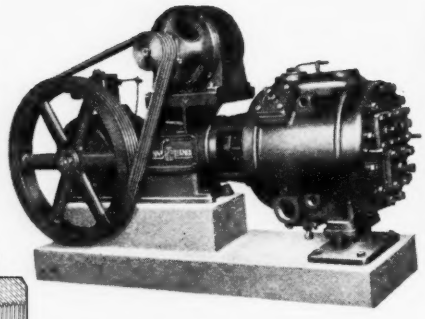
American District Steam Co., North Tonawanda, N. Y.



RELIEF VALVE

USING cup-shaped in place of flat valve disk, relief valve is said to hold curve of pressure vs. discharge nearer to ideal. Pressure transmitted to space within cups is confined and made uniformly effective over entire inner head of cup disk, regardless of valve opening. Open-end pitot tube facing upstream compensates for loss of pressure due to pipe friction, or due to conversion of static pressure to velocity head between larger pipe and valve inlet. Long spring initially compressed used so loading on disk does not vary more than a few % between zero and full valve opening. Increase in velocity head compensates for increase in spring tension as valve opens. Outside sleeve surrounding cup disk prevents fluid pressure in outlet compartment of body from acting on top of disk and tending to close valve.

Klipfel Mfg. Co., 2641 W. Harrison St., Chicago, Ill.



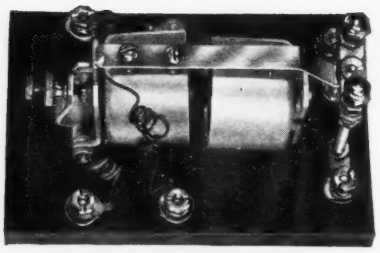
VACUUM PUMPS

SINGLE-STAGE and 2-stage, horizontal, roller-bearing type, air-cushion-valve vacuum pumps, Class 7-AT and 8-AT, for power and steam drives have frame opened over crank end of main bearings with cast aluminum cover. Distance piece scraper rings placed between cylinder and frame to keep crankcase oil from vacuum cylinder. Connecting rod is steel forging with solid eye at each end. Forged-steel crankshaft has tapered ends to fit wheel hubs. Box-type crosshead. Bulletin No. 166.

Pennsylvania Pump & Compressor Co., Easton, Pa.

CIRCUIT BREAKERS

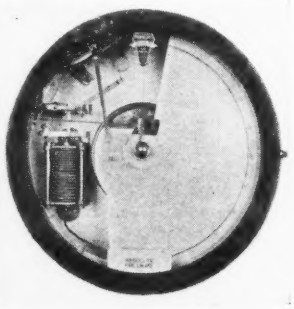
INCLOSED Type AB-F "Flipon" 15 to 50-amp. circuit breakers for protection and control of single-phase lighting and motor circuits, etc., have automatic tripping independent of manual toggle type operation. Butt-type contacts. Thermally actuated bi-metals with inverse time lag for over-current operation. Type AB-1 "De-ion" breaker for main services, light and power systems. Four groups of ratings from 15



RELAY CONTROL FOR CHARGING

TO CONTROL charging of battery sets with three different voltages, relays are wound to pick up on 24 volts and drop out at approximately 22 volts. Resistors placed in series with coils for operation on 4 volts differential on 48 volts and 12 on 132 volts. When battery voltage is normal, relay armature is picked up, opening contact which inserts resistor in field of generator, placing battery on trickle charge. When battery voltage drops, armature drops out, short circuits resistor, and places battery on full charging rate. Other types.

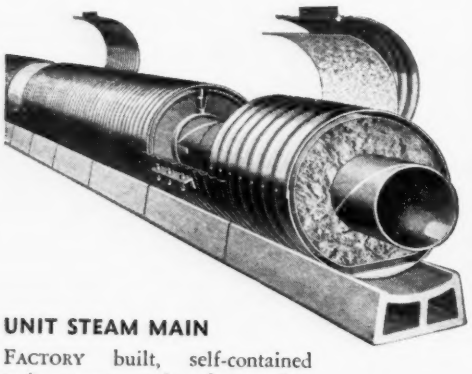
Struthers Dunn, Inc., 139 North Juniper St., Philadelphia.



PRESSURE GAGE

PRESSURE measuring and barometric compensation units mounted together in absolute pressure gage which has two hydrons, measuring direct and barometric pressures, so connected that pressures oppose each other. Compensating hydron, sealed under vacuum, counterbalances barometric effect on main pressure hydron. Contains no liquid.

Foxboro Co., Foxboro, Mass.



UNIT STEAM MAIN

FACTORY built, self-contained unit steam main for underground distribution lines. Built with galvanized and asphalt coated "Armco" iron, with waterproof, asbestos insulation. Unit entirely assembled, including pipes, supports, liner, conduit sections, and all accessories. Entire system in portable units. Bulletin.

RicwiL Co., 1562 Union Trust Bldg., Cleveland, Ohio.

BLOWERS

USING rotary positive principle, these blowers have all pipe connections below floor level. Built for top discharge, ducts are carried down side of and integral with cylinder casting. Built-in manual volume controls to vary capacity.

Roots-Connersville Blower Corp., Connersville, Ind.

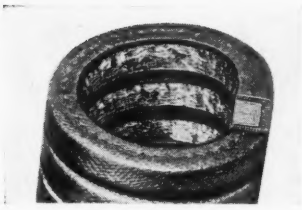
to 600 amp., either 250-volt a.c., 125/250 volts d.c., or 600 volts a.c., 250 volts d.c. Thermal and magnetic trip separate on all frames above 50-amp. size. Trip units available in ratings corresponding to standard wire and cable sizes. Sheet-steel, weatherproof, explosion-resisting, and submersion-proof inclosures.

Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

RELAYS FOR RECTIFIERS

TYPE CAW induction-cylinder power relays for protecting mercury-arc rectifiers develop torque by inducing eddy currents in aluminum, cup-shaped rotors turning in annular air space inside symmetrically arranged magnetic poles. Central core fixed to stator frame.

General Electric Co., Schenectady, N. Y.



SEMI-METALLIC PACKING

COMPOSED of insert of thin ribbons of soft babbitt foil, formed so that edge of foil contacts moving surface of rod on which it is used, "John Crane, Style 300, Edge-On" packing recommended up to 450 deg. F. Convolutions of foil provide reservoirs filled with special graphited lubricant extruded onto moving surface under adjusting pressure of gland. Insert is fastened to heat-resisting asbestos channel impregnated with lubricant.

Crane Packing Co., 1801 Cuyler Ave., Chicago, Ill.

SHEAVES

FOR V-belt drives, line of "Duro-Brace Texsteel" sheaves has been extended to include 15-hp. sizes. Grooved design for use with either A or B section belts. Standard line now includes 25 different diameters from 3 to 18 in., for two to six grooves. Interchangeable type hubs with bores in $\frac{1}{16}$-in. increments from $\frac{1}{2}$-in. up.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

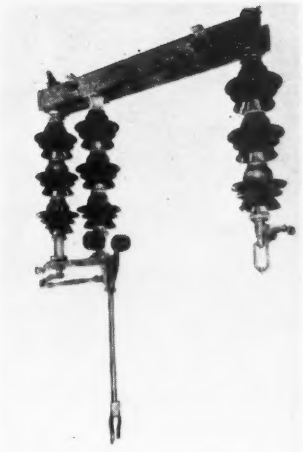
BUS SUPPORTS

FOR use with various sizes of indoor buses and voltages up to 27 kv., reinforcing ribs of these bus supports can be drilled and tapped for a spacer insulator to take up short-circuit stresses between buses.

Delta Star Electric Co., Chicago, Ill.

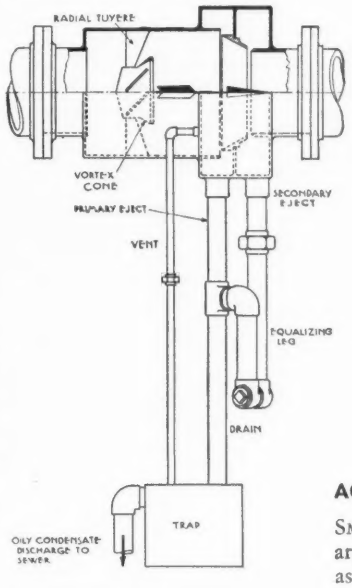
HIGH-VOLTAGE BLADE SWITCHES

MOTOR- or manual-operated high-voltage balance-blade switches rated at 115/132-S-kv., 600 amp., assembled for inverted mounting, are so adjusted that should any link of mechanism fail it will not fall open or fly closed. Two rotating insulator stacks per pole at blade hinged end, and contact end. Stack operates crank arm



connected to hinged blade on stationary stack, blade being lowered or raised from this point. Rotating stack operates main H-shaped contact. In opening operation, rotating stack at contact ends first turns to entirely release H-shaped contact from blade's forked contact. Rotating stack at hinged end then turns, lowering blade to full open position. Reverse operations for closing. Forked blade main contact shoe is hard drawn copper fitting within floating polished stainless steel spring which with copper contact shoe is supported by bronze casting clamped to blade.

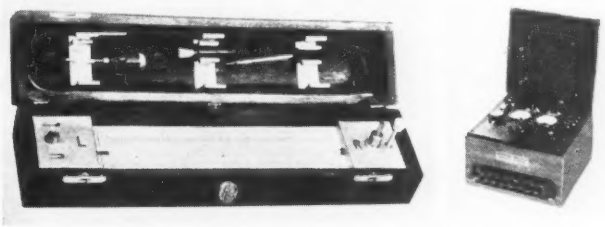
Delta Star Electric Co., 2400 Block Fulton St., Chicago, Ill.



OIL SEPARATOR

TYPE RV purifier to remove oil from exhaust steam has two separating stages. First, recovers bulk of entrainment, while the second acts as refining stage. Steam passes through tuyere consisting of number of radial blades inclined at 45-deg. angle, causing whirling motion which throws entrainment outward and forward in spiral direction along inner surface of sleeve until primary discharging slot is reached. Entrainment is driven through slot into outer concentric pocket by centrifugal force. Operation is repeated at secondary slot. Effect of vortex is prevented by vortex cone. Casing fabricated by electric arc welding.

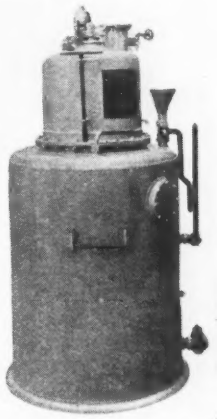
Centrifix Corp., 3029 Prospect Ave., Cleveland, Ohio.



AIR METER

FOR steady measurement of pressure or vacuum, and velocities of air inside ducts, at grilles, fans, etc., this air meter covers velocities as low as 140 f.p.m., and up to 2,832 f.p.m., and pressure or vacuum from 0.00125 in. to 0.50 in. of water. Zero correction and leveling devices integral parts of instrument. Complete in portable case, $3\frac{1}{4}$ x $3\frac{1}{4}$ x $14\frac{3}{4}$ in. Net weight, 2 lb. 3 oz. Bulletin No. F.

***Julien P. Friez & Sons, Inc.**, Baltimore St. & Central Ave., Baltimore, Md.*



ACETYLENE GENERATOR

SMALL-SIZE, portable or stationary acetylene generator, known as "Oxweld Type MP-6-Medium Pressure," has 50-lb. carbide capacity with double rating of 100 cu.ft. of acetylene per hr. Handwheel at generator top to control carbide feed so that acetylene at any pressure up to 14 lb. per sq. in. may be obtained. On trucks for transportation or fitted for permanent installation supplying acetylene through pipelines.

Linde Air Products Co., 30 East 42nd St., New York, N. Y.

ELECTRONIC TIMER

ELECTRONIC timer reads directly thousandths of a second by charging condenser at known rate during interval, then measuring voltage built up on condenser. Condenser charging controlled by two Thyratron tubes, one to start, other to stop current flow. Condenser voltage measured by vacuum-tube voltmeter using bridge circuit so that condenser charge is maintained during reading period. All equipment in box with terminals for connecting to 115 volts, 60 cycles, a.c., and 125 volts, d.c., supply.

General Electric Co., Schenectady, N. Y.

TEMPERATURE CONTROL UNIT

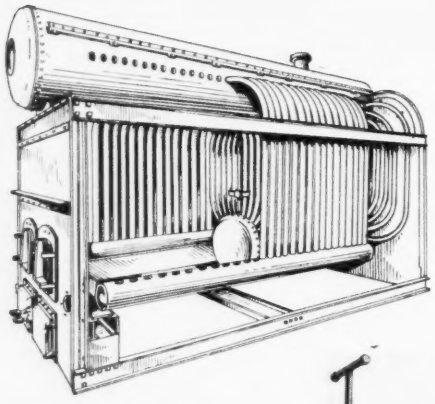
GLASS - inclosed thermostat mounted with guard in cover of standard 4 x 5-in. switchbox operates glass-inclosed relay in box, rated at 400 watts in temperature control units for use in dead air spaces. Both relay and thermostat are hermetically sealed in glass-encasing tubes filled with inert gas of high thermal conductivity to prevent arcing when contacts open.

Thomas A. Edison, Inc., West Orange, N. J.

RUSTPROOFING PROCESS

"CROMODIZING" for protecting steel surfaces by dipping or spraying with solution of proprietary chemical called Cromodine for 1 min. Metal is first cleaned, and following chemical treatment, is rinsed and dried. Said to change surface instead of coat, producing smooth surface, easy to paint, better finish.

American Chemical Paint Co., Ambler, Pa.



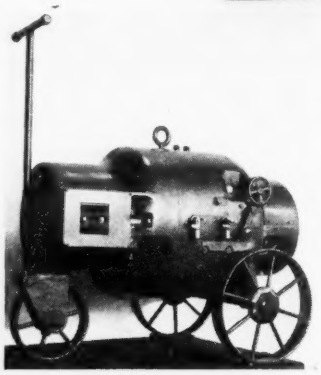
WATER TUBE BOILER

TYPE "CP" water-tube boiler, completely steel-encased and insulated, has no brickwork except for front wall and bridge wall, has water-cooled furnace sides and built-in soot blower. Sizes to 2,500 sq.ft., pressures 450 lb. Staggered tubes cause continued breaking up and uniting of gases. Water walls extend along each side of setting. Top ends of waterwall tubes discharge directly into upper drum. Lower ends terminate in headers extending from front to rear. Rear ends of headers are connected to rear end of lower drum by means of circulating tubes. Openings with renewable covers in front side of headers open to lower ends of water-wall tubes. Handhole at front and blow-off at rear. Illustration shows boiler partly assembled. Bulletin No. F8.

E. Keeler Co., Williamsport, Pa.

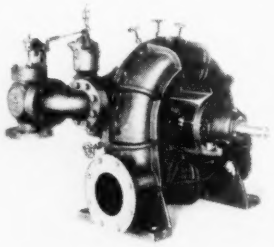
D. C. WELDER

"FLEXARC" d.c. welder with single-dial preset control sets current to maintain constant arc despite speed changes of driving motor. Open-circuit voltage below hazardous values provides safety for operator, yet retains desirable arc characteristics. Set adjusts itself to preset value when arc is struck. Outer shell is two parts bolted together; 1-piece common shaft supported by two ball bearings. Generator utilizing magnetic shunt in armature reaction flux path, has no shunt field and requires no field rheostat, exciter, or external reactor. Output current adjusted by iron damper plates operated by single-point "adjustomatic" control. Plates serve as magnetic shunt for reaction flux. Damper coils on plates prevent surge and droop of welding current. To set welding current, operator turns handwheel until current dial geared to handwheel shaft reads desired value. Squirrel-cage induction driving motor has die-cast aluminum rotor overhung on generator



shaft, and blowers cast integral with rotor bars. Stator core and coils form pre-wound stator unit pressed into frame.

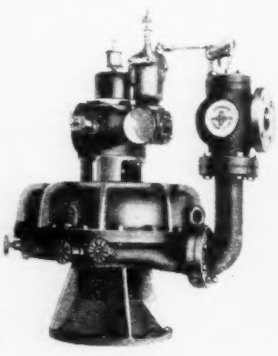
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

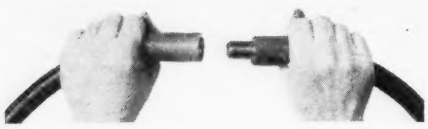


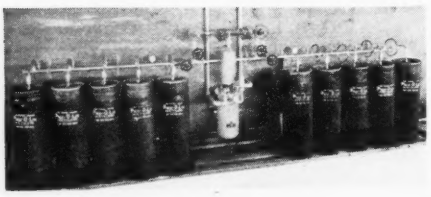
STEAM TURBINES

Two units added to line of steam turbines for both horizontal and vertical operation extends range from 60 to 150 hp. 22-in. 2½ turbine for output up to 90 hp., and 22-in., 3 turbine for output up to 150 hp. Units now furnished with built-in speed reducers for driving low-speed equipment. Bulletin No. 135-8.

Coppus Engineering Corp., Worcester, Mass.







ACETYLENE CYLINDER MANIFOLD

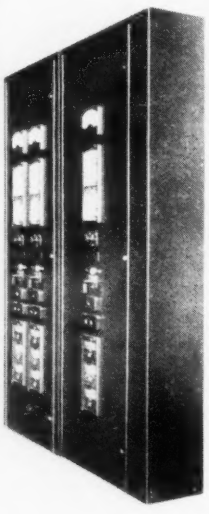
WALL-TYPE "Oxweld Type M-8" available in 10-cyl. units, to which extensions in units of five or ten cylinders can be made has two high-pressure feeds into central regulation system, which delivers acetylene to distribution piping system at pressures up to 15 lb. per sq.in. Header unit assemblies of seamless steel tubing with forged-steel union connections, stainless steel seat inserts. Header valves for cylinder connections threaded directly into steel tubing header. Connections from header valves to cylinder valves made with flexible leads and provided with ball check valve in header end.

Linde Air Products Co., 30 East 42nd St., New York, N. Y.

SWITCHBOARDS

"STREAMLINED" steel switchboards have all devices built in, instead of hung on panel faces. Instruments project about an inch from panel front. Construction applied to vertical switchboards, benchboards, crucible doors, metal-clad front inclosures, and swinging brackets. Use dead-front type air circuit breakers.

General Electric Co., Schenectady, N. Y.



CABLE CONNECTOR

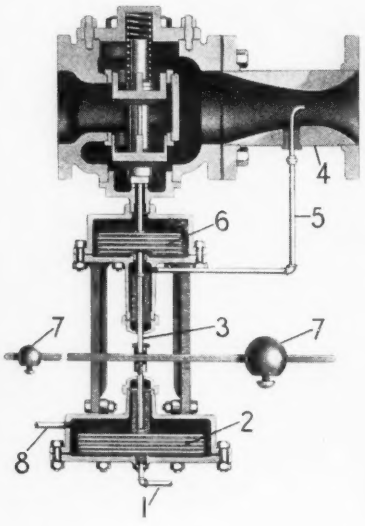
QUICK-DETACHABLE connector for connecting welding or electrode cable locks in position and cannot work loose nor be accidentally pulled apart. Plug inserted in jack and locked by twist. To disconnect, procedure is reversed. Protection against grounding by fiber insulating sleeves.

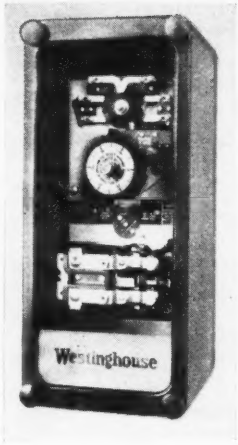
Lincoln Electric Co., Cleveland, Ohio.

CONTROL FOR HEATING SYSTEM

"SARCO GRADUATOR" system for automatic control of heating in large buildings can be applied to 2-pipe steam-heating systems of all types. One thermostat outside building and one inside regulate steam supply in accordance with building heat loss. Automatic graduator at each radiator inlet for uniform steam distribution. Outdoor thermostat, an air-filled, sealed tank, connects to main steam supply valve (illustrated) by copper tubing (1). Temperature increase expands air in tank and puts pressure on bellows (2) pushing valve stem (3) upward, tending to close valve. Pitot tube (5) in throat of tube (4) conveys impact pressure of steam to auxiliary bellows (6). Action of this bellows depends on volume of steam flowing since outside is acted on by static pressure and inside by impact pressure. Weights (7) adjust valve travel to local conditions and admit right amount of steam to maintain room temperature. Inside thermostatic air valve admits atmospheric pressure to outside of bellows (2) through copper tube (8) unless overheating occurs. Overheating closes inside valve, causing vacuum outside bellows (2) which expands and closes valve.

Sarco Co., Inc., 183 Madison Ave., New York, N. Y.

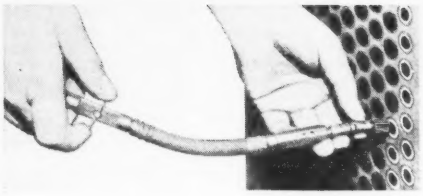




AUTOMATIC RECLOSER

MOTOR-OPERATED, Type RC, timing recloser has integrating lockout device for a.c. or d.c. electrically-operated breakers on a.c. systems. Consists of synchronous motor-driven set of cams and two self-contained auxiliary elements which provide initial immediate or delayed reclosure and several subsequent reclosures with reset if breaker stays in and lockout fails to stay in. For breakers with full-automatic mechanism, initial immediate reclosure is obtained without use of latch checking or other auxiliary devices. Intergrating lockout can be set for any number of total reclosures up to 16.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



SMALL TUBE CLEANER

"ROTO JR." air driven cleaner for small tubes has scraper head replaceable blades, universal joint for attaching cleaning heads to motor and air valves directly behind motor for one-man operation. For straight tubes down to $\frac{5}{8}$ in. O.D. and curved tubes with short-radius bends down to $\frac{7}{8}$ in. O.D. Motor with two moving parts operates at pressures of from 30 to 75 lb. with air consumption of 12 to 20 cu.ft. per min.

Roto Co., 142 Sussex Ave., Newark, N. J.

CALCULATIOR AND FUNCTION TABLE

"TRIGONOGRAPH", based on "unit circle principle" has movable hypotenuse attached to 45-deg. right triangle, both decimally divided. Moving hypotenuse through an angle graphically indicates to two or three places, ratio between sides of right triangle. By using unit length for a side, ratios will be expressed in terms of six trigonometric functions: Sine, Cosine, Tangent, Cotangent, Secant and Cosecant. Auxiliary scale is provided for solution of oblique triangles. Made in celluloid and cardboard.

Chemical Rubber Publishing Co., 1900 West 112th St., Cleveland, Ohio.

FIRE-PROOF ELEVATOR CABLE

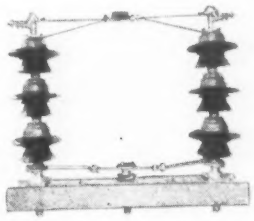
FIRE-PROOF, multi-conductor elevator control cable, resists moisture, oil and corrosive vapors. Any length; up to 37 conductors. Flame-resisting and waterproof rubber insulates flexible copper strands. Felted asbestos over rubber insulation by "Deltabeston" process. Conductors color-marked, and individual conductors cabled together with fire-resisting fillers. Cable bound with single-faced rubberized tape, finished with asbestos-yarn braid saturated with flame-proof and moisture-resisting compound.

General Electric Co., Merchandise Dept., Bridgeport, Conn.

PORTABLE TEST UNITS

FOR general testing, laboratory and radio work, this line of portable volt-ohmmeters and test units are equipped with d'Arsonval movements, and selector switches for range selection. Types available include simple ohmmeters, volt-ohmmeters, d.c. test units and more elaborate multi-scale a.c.-d.c. test units. Instruments weigh approximately 2 lb., have scales 2.4-in. long, accuracy within 2% for d.c. volts and milliamperes, and within 5% for a.c., and are mounted in 7 x 4 x $3\frac{1}{4}$-in. Moldarta case.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



HORIZONTAL BREAK SWITCH

"PM FORM 2" switch for 115/132-S K.V. has blade of two equal lengths contacting at center point. Each half-blade carried on insulator stack on ball bearings. Blades open out on same side of switch and in full open position are parallel to each other and at right angles to mounting base. Opens quickly, introducing wide gap and carrying arc out into unionized air. Assembled in 3-pole combinations, either motor or manually operated.

Delta Star Electric Co., Chicago, Ill.

MANUFACTURER'S BULLETINS

Dust—Buell Engineering Co., 70 Pine St., New York, N. Y. 8-page, two-color bulletin describes dust collection and elimination equipment, and "Van Tongeren" system. Extensively illustrated with photos and diagrammatic sketches.

Compressors—Carbondale Machine Corp., Harrison, N. J. 6-page, two-color folder, Bulletin 1107, describes and pictures vertical, duplex, type refrigeration compressors. Gives specifications and dimensions.

Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. Two bulletins, No. W-102-B1, six-page folder on horizontal-duplex piston-pumps for general services at pressures up to 200 lb. per sq.in., and 4-page folder No. W-312-B1A, on single-stage volute Type LT centrifugal pumps for pumping hot and volatile liquids at temperatures up to 600 deg. F.

Motors—Reliance Electric & Engineering Co., Ivanhoe Road, Cleveland O. Two four-page, two-color bulletins on fully-inclosed, fan-cooled induction motors for two- and three-phase circuits, Bulletin No. 120 for 2 to 15 hp. (1150 r.p.m.) and No. 121 for 20- to 100-hp. (1200 r.p.m.).

Blast Gates—W. S. Rockwell Co., 50 Church St., New York, N. Y. Single sheet, Catalog No. 355, gives complete information on line of Butterfly-type blast gates.

Boiler Chemicals—Monsanto Chemical Co. St. Louis, Mo. 24-page illustrated November issue of monthly "Current Events." Contains stories of general interest and company news.

Valve Specialties—Davis Regulator Co., 2541 S. Washtenaw Ave., Chicago, Ill. Two 32-page illustrated bulletins No. 100 on pressure regulators, governors and strainers, and No. 101 on fluid level controllers, numerous types of valves, traps and air vents.

Pipe Fittings—Taylor Forge & Pipe Works, P. O. Box 485, Chicago, Ill. Three pages containing important revisions in Catalog 34-1, covering Taylor Forge seamless steel fittings for welding.

Refractory Cement—Johns-Manville, 22 East 40th St., New York, N. Y. 12-page booklet, "Fire Tamers" describes laboratory research on line of refractory material.

Special Pumps—Allen-Sherman-Hoff Co., Lewis Tower, Philadelphia, Pa. 24-page well illustrated Catalog No. 735-A describes Hydroseal sand pump and Maximix acid-resisting pump, showing construction, operation and uses.

Pumping System—Ingersoll-Rand Co., 11 Broadway, New York, N. Y. 24-page Bulletin No. 9042 describes method of air-lift pumping of water, oil or other fluids. Gives advantages over other methods, applications, theory and illustrates number of different compressors for supplying air.

Pumps—Quimby Pump Co., 340 Thomas St., Newark, N. J. 4-page, two-color Bulletin No. R-200, illustrates operation, gives specifications and capacity ratings for line of "Rotex" pumps.

Carbon Brushes—Ohio Carbon Co., 12508 Berea Road, Lakewood, O. Loose-leaf, pocket-size catalog containing full data on types of carbon brushes for general use, including mainly fractional horsepower, direct-current and single-phase repulsion-induction alternating-current motor brushes.

Diesel Purifier—Goulds Pumps, Inc., Seneca Falls, N. Y. 6-page Bulletin No. 501 describes "Hydroil Centrifugal Purifiers" for purifying diesel lubricating oil and fuel.

Brushes—David Linzer & Sons, Inc. 10-20 Astor Place, New York, N. Y. 64-page catalog announces new line of brushes known as Compo-Fibre.

Emergency Lights—Electric Storage Battery Co., Philadelphia, Pa. "Exide News" published monthly, 4-page illustrated pamphlet with one page on Exide "Keepalite" emergency lighting systems.

Pipes—Republic Steel Corp., Massillon, Ohio. 16-page two-color folder "The Greatest Pipe Show on Earth" lists and describes various types of tubular products manufactured by Republic and its subsidiary Steel & Tubes, Inc.

Stoker—Combustion Engineering Co., Inc., 200 Madison Ave., New York, N. Y. 8-page attractively illustrated bulletin on the "Design MRO" multiple-retort stoker. Includes test data and operating results.

Testing Kits—National Aluminate Corp., 6216 W. 66th Place, Chicago, Ill. Circular describes construction, content, and gives prices of "Nalco" colorimetric testing kits.

Flexible Couplings—John Waldron Corp., New Brunswick, N. J. 12-page Catalog No. 50 describes and illustrates changes in "Francke" flexible couplings. Includes also complete tables of sizes for various types, directions for selection, and coupling service factors.

Regulators—Fisher Governor Co., Marshalltown, Iowa. 76-page, two-color, illustrated Catalog No. 32-A covers complete line

of automatic controls for gas industry. Gives dimensions, construction features, prices, and capacity charts.

Commutators—Ideal Commutator Dresser Co., Sycamore, Ill. 64-page Catalog No. H535, illustrated, lists line of commutation products, information on care and servicing of commutators and slip-rings, electrical data and definitions.

Pipe Joints—S. R. Dresser Mfg. Co., Bradford, Pa. 16-page booklet No. 355 includes installation pictures, general information on pipe line products, and construction data.

Boilers — Combustion Engineering Co., Inc., 200 Madison Ave., New York, N. Y. 4-page folder lists and illustrates products for boiler plants.

Rolled Steel—Illinois Steel Co., 208 S. La Salle St., Chicago, Ill., and Carnegie Steel Co., Pittsburgh, Pa., have collaborated in the preparation of 16-page, illustrated, technical booklet on rolled steel for machine construction. Contains suggestions on forms of steel available, combination of rolled steel and castings, and welding technique, stress relief, etc.

Steam Conduits—H. W. Porter & Co., 825 Frelinghuysen Ave., Newark, N. J. 8-page Bulletin No. 352 contains specifications for complete system of steam conduits, protection and insulation of pipe lines between buildings, cross-sections of typical installations, and layouts.

Alloy Steels—Bethlehem Steel Co., Bethlehem, Pa. 16-page Bulletin No. 88 contains physical property charts for each of seven types of alloy steel, and complete description

V-Belts—Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., Passaic, N. J. Bulletin No. 6840, 4-page leaflet, describing and explaining details and construction of "Condor" V-belts. Diagrams illustrate technical data.

Traps—Hoffman Specialty Co., Inc., Waterbury, Conn. 12-page cut-away bulletin illustrates in detail Hoffman No. 8A thermostatic trap. Also other steam-line equipment.

Fuses—Schweitzer & Conrad, Inc., 4435 Ravenswood Ave., Chicago, Ill. Bulletin No. 200C, four-page leaflet on high capacity Type C Fuse for substation and industrial service. Construction, operation and application included, together with dimension data and ratings.

Disconnect Switches — Schweitzer & Conrad, Inc., 4435 Ravenswood Ave., Chicago, Ill. Bulletin No. 222-A, four-page leaflet, illustrates, gives dimensions and ratings for wire type, multi-point contact, disconnecting switches.

Welding Rods — American Manganese Steel Co., Chicago Heights, Ill. 6-page leaflet No. 20 describes Amsco hard-facing welding rods Nos. 459 and 217. Gives technical data and illustrates applications.

Transformers — Allis-Chalmers Mfg. Co., Milwaukee, Wis. 8-page Bulletin No. 1173 shows in unique way exterior and cutaway interior views of line of distribution transformers.

Bearings—S K F Industries, Inc., Front St. & Erie Ave., Philadelphia, Pa. 32-page catalog shows load ratings and diagrams of mountings for ball- and roller-bearing pillow blocks, flanged housings, etc. Also discusses bearing problems, selection, and gives dimensional and load data.

Packings—Belmont Packing & Rubber Co., Butler & Sepviva Sts., Philadelphia, Pa. Three separate folders describe packings for oil and gasoline, steam and water service. Include illustrations and recommendation charts.

Cable—General Electric Co., Schenectady, N. Y. 28-page Bulletin No. GEA-1278B describes conductor, insulation, treatment and lead-sheath on paper insulated cable. Gives insulation thickness and other data.

Regulator—Allis-Chalmers Mfg. Co., Milwaukee, Wis. 8-page illustrated leaflet No. 2204 describes and gives complete technical data on Type BFR branch feeder regulators.

Controllers—Foxboro Co., Foxboro, Mass. 20-page, well illustrated, Bulletin No. 202 covers line of potentiometer and resistance thermometer controllers. Gives complete list of ranges and number of simplified wiring diagrams.

Starters—Lincoln Electric Co., Cleveland, Ohio. Two single sheets illustrate and describe construction and operating characteristics of automatic motor starters.

Gearmotors — Allis-Chalmers Mfg. Co., Milwaukee, Wis. 4-page illustrated leaflet No. 2203 describes and shows applications for self-contained speed reducers with integral or attached motor.

Gear Motors—Dominion Engineering Co., Ltd., Montreal, Canada. Bulletin No. 129, 16 pages, illustrates and gives complete data, including dimensions and horsepower-ratio tables for line of gear motors, of this company.

Tubes—Scovill Manufacturing Co., Waterbury, Conn. 4-page Bulletin No. 3 gives base prices and specifications for line of condenser and heat exchanger tubes.

Carbide Residue—Linde Air Products Co., 30 East 42nd St., New York, N. Y. 20-page booklet, "Utility of Carbide Residue," explains how residue of acetylene generators may be used as principal ingredient in whitewash, fireproof cement, mortar, plaster, concrete, etc.

Pumps—Lawrence Pump & Engine Co., Lawrence, Mass. 8-page bulletin describes "Electropumps," centrifugal pumping units for small and large capacities. Several tables give heads and capacities for various pumps.

Fan Assemblies—John J. Nesbitt, Inc., Holmesburg, Philadelphia, Pa. 59 loose leaf pages in Bulletin No. 227, describes "Nesbitt Series B Thermovent" fans for heating and ventilating large interiors. Divided into five sections, giving three control cycles installation and detail drawings.

Blast Gates — W. S. Rockwell Co., 50 Church St., New York, N. Y. Catalog No. 353, covering "Kwikleen" blast gates. Illustrates and gives dimensional data.

Wind Equipment — Julien P. Friez & Sons, Inc., Baltimore St. & Central Ave., Baltimore, Md. 16-page, illustrated bulletin describes line of instruments for determining and recording wind conditions.

Alternators — Allis-Chalmers Mfg. Co., Milwaukee, Wis. 24-page Bulletin No. 1153-A on engine-type alternators for use with reciprocating prime movers. Includes pictures of construction, application and auxiliaries.

Light Products—Pittsburgh Plate Glass Co., Grant Bldg., Newark, N. J. 32-page, two-color, illustrated bulletin gives quantitative and qualitative discussion on light. Economics of lighting and effects of paint.

Condensers—Aerovox Corp., 70-82 Washington St., Brooklyn, N. Y. 24-page illustrated Catalog No. 152 gives complete data on condensers and power factor correction equipment.

Refractory Cement—Norton Co., Worcester, Mass. 8-page leaflet No. 863 gives data, instructions for use, and illustrations of refractory cement. Also conversion and melting point tables.

Speed Control—Reeves Pulley Co., Columbus, Ind. 112-page Speed Control Handbook illustrates and describes methods of variable speed regulation, typical applications, and gives technical data with dimensions, drawings and tables for design.

Synthetic Rubber—B. F. Goodrich Co., Akron, Ohio. 12-page illustrated Bulletin No. 1050 describes properties, available forms and uses of "Koroseal" synthetic rubber-like material.

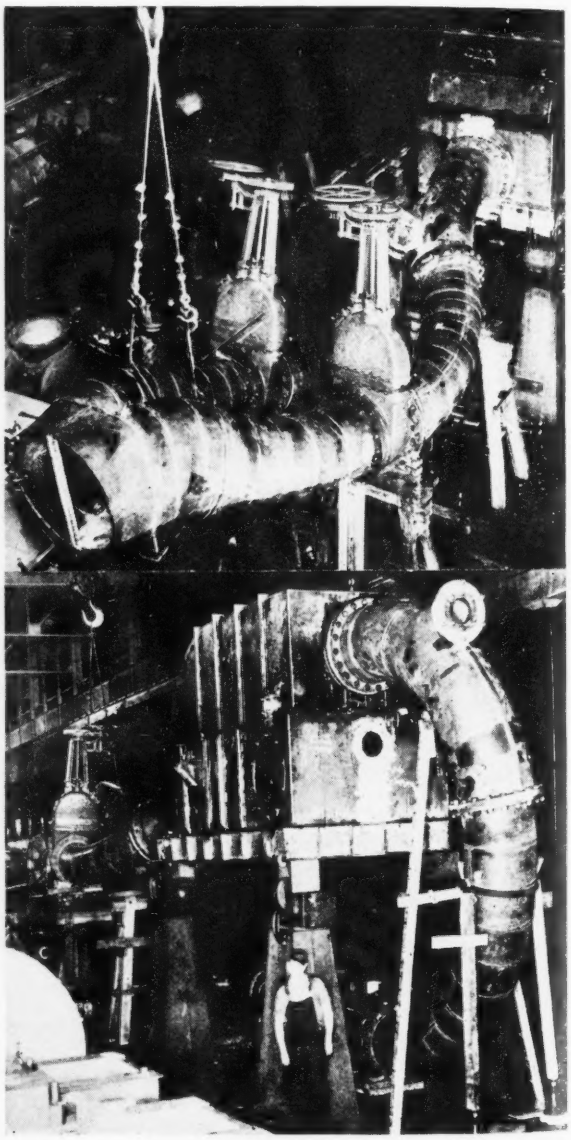
Stop Nut—Elastic Stop Nut Corp., Elizabeth, N. J. 16-page Catalog No. A-43 contains design information, applications and specifications for elastic stop nuts.

Welding Rod — American Manganese Steel Co., Chicago Heights, Ill. 6-page folder Bulletin No. 10 gives applications and suggestions for welding with "Amsco" nickel manganese steel welding rods.

Stokers—McClave-Brooks Co., Scranton, Pa. 8-page leaflet illustrates and describes forced draft chain grate stoker and operating mechanisms.

Mica Cutter—Ideal Commutator Dresser Co., Sycamore, Ill. 4-page illustrated technical bulletin describes electrically-driven "ideal" undercutter with micrometer gage for servicing commutators.

SOUTHERN UTAH HYDRO



These are not the remains of some prehistoric monster, but penstock and nozzle connections to a 1,570-hp. double-jet S. Morgan Smith impulse water wheel for Southern Utah Power Co., Cedar Falls, Utah. Runner is 49.5 in. in diameter and under 215-ft. head, operates at 257 r.p.m. One of few double-jet impulse wheels installed in North America. Y-connection (lower left in upper photo) is circular at Penstock end and at valve connections, but oval cross-section between. Welded construction with cast nozzle supports. New unit replaces one of much smaller capacity, causing complicated arrangement

Welding—Linde Air Products Co., 30 East 42nd St., New York, N. Y. 8-page, illustrated, booklet on repair of cast iron machinery by oxyacetylene welding process.

K.V.A. Meter—Esterline-Angus Co., Indianapolis, Ind. 4-page illustrated Bulletin No. 735 describes construction, operation and application of graphic K.V.A. meter.

Conveyors—Jeffrey Mfg. Co., Columbus, Ohio. 112-page illustrated Catalog No. 610 lists complete line of standardized belt conveyors and accessories.

Heating System—Hoffman Specialty Co., Inc., Waterbury, Conn. Large three-color folder illustrates and describes Hoffman "Talmadge," zoned, controlled, heating system.

Turbines—De Laval Steam Turbine Co., Trenton, N. J. 4-page reprint of article from "Nautical Gazette," on use of geared turbines on "S.S.G. Harrison Smith."

Unit Heaters—Modine Mfg. Co., Racine, Wis. Catalog No. 635 describes current and new models of line of unit heaters.

Couplings—John Waldron Corp., New Brunswick, N. J. 4-page Bulletin No. 51 describes, illustrates, and gives ratings and dimensions for line of cross-type, flexible couplings.

Flow Meters—Brown Instrument Co., Wayne & Roberts Ave., Philadelphia, Pa. 8-page folder No. 80-34-60 pictures various types of flow meters and number of recent installations.

Bearings—S K F Industries, Inc., Philadelphia, Pa. 10-page Bulletin No. 230 and four single sheets discussing use of bearings for main spindles. Illustrations show various types of mountings, assembly and construction of spindles.

Meters—Foxboro Co., Foxboro, Mass. 8-page illustrated folder No. 677 shows various flow meters and particular applications.

Fuse Links—General Electric Co., Schenectady, N. Y. 4-page Bulletin No. 1994A illustrates and gives applications and operating characteristics of universal fuse links for expulsion-type distribution fuse cutouts.

Superheaters—Superheater Co., 60 East 42nd St., New York, N. Y. 6-page silver and black folder gives 25-year history of manufacturing company.

Celite—Johns-Manville, 22 East 40th St., New York, N. Y. 24-page booklet No. FA-7A details history, development and industrial uses of diatom plant from which Celite is made. Four sections devoted to high-temperature insulation, filter aid, mineral filler, and workability agent in concrete. Appendix contains technical data regarding Celite and uses.

Motors—Reliance Electric & Engineering Co., Ivanhoe Road, Cleveland, Ohio. Two 4-page bulletins on squirrel-cage induction motors. No. 118 for motors of 1 to 25 hp., and No. 119 for 25 to 150 hp.

Worthington—Worthington Pump & Machinery Corp., Harrison, N. J. Five bulletins: W-210-B17, "Deaerating Feedwater Heaters"; W-450-B24, "Deep Well Turbine Pumps"; L-611-B5A, "Single Horizontal, Single-Stage Steam and Motor-Driven Compressors with 5-, 7-, 9-in. Stroke"; L-611-B4A, "Single Horizontal, Single-Stage, Steam and Motor-Driven Compressors with 11x13-in. Stroke," and WP-1088, dealing with a term-payment purchase plan developed to enable purchasers to take advantage of provisions of National Housing Act.

Diesel Engines—Caterpillar Tractor Co., Peoria, Ill. 14-page Bulletin No. 2984, profusely illustrated, answers the questions "Why the Diesel?", "How Does the Diesel Run?" and "What Do Owners Think?"

Friction Materials — Johns-Manville, 22 East 40th St., New York, N. Y. 8-page Bulletin No. FM-4A, contains description of line of industrial friction materials, two tables of characteristics, and numerous installation photos.

Circuit Breakers—I.T.E. Circuit Breaker Co., Philadelphia, Pa. 4-page Bulletin No. 1035 illustrates construction, operation and applications for self-actuated reclosing circuit breakers.

Bakelite—Bakelite Corp., 247 Park Ave., New York, N. Y. 40-page, profusely illustrated, two-color booklet traces 25-year history of company, discusses personnel, process, present applications and new research.

Wide World

TVA's Wheeler Dam on the Tennessee River, 15½ miles above Wilson Dam, Ala., is well under way. Power house in foreground

Insulation—Johns-Manville, 22 East 40th St., New York, N. Y. 48-page Catalog No. GI-4A illustrates application of insulation, packing, refractories, roofing and siding, flooring, friction materials, electrical materials, transite pipe, etc. Details of construction, specifications, dimensions.

Air-Conditioning — York Ice Machinery Corp., York, Pa. Single sheet illustrates number of recent store installations.

Valves, Etc.—Kieley & Mueller, Inc., 34-38 West 13th St., New York, N. Y. 164-page Catalog No. 57 (revised) covers complete line of steam, water, air, gas and oil specialties for power plants, plumbing and heating systems, gas and oil fields.

Synchronous Drives — General Electric Co., Schenectady, N. Y. 4-page leaflet No. GEA-2177, shows applications for Power Selsyns, self synchronous apparatus.

Unit Heaters—Trane Co., La Crosse, Wis. 24-page, two-color, profusely illustrated bulletin describes in detail and gives specifications for line of unit heaters.

Time Switches—General Electric Co., Schenectady, N. Y. 8-page Bulletin No. GEA-1427D illustrates and gives complete technical and dimensional data on Types T-17 and T-27 time switches; also applications.

Tube Fabricating Equipment — Parker Appliance Co., Cleveland, Ohio. 24-page Bulletin No. 40 illustrates, describes and gives prices on complete line of tube fabricating equipment and instructions for use.

Blower-Separator—American Air Filter Co., Inc., Louisville, Ky. 8-page Bulletin No. 270-H, illustrates, describes and gives engineering data and specifications on "Roto-Clone" Type D Dynamic Precipitator, combined exhauster and dust separator.

Fans—Aerovent Fan Co., Piqua, Ohio. 32-page illustrated bulletin gives complete general and technical data on "Macheta" airfoil fans. Shows various applications and gives physical fan laws.

Gaskets—Goetz Gasket & Packing Co., Inc., New Brunswick, N. J. 64-page Catalog No. 48 on metallic and semi-metallic gaskets, sheet and stuffing box packings, sealing compounds, gasket cutting tools, valve discs, filter screens and metal stampings.

Resurfacer—Flexrock Co., 800 N. Delaware Ave., Philadelphia, Pa. One-page folder explains uses of "Ruggedwear Resurfacer," and methods of applying to industrial floor repairs.

Chrome Brick—General Refractories Co., 106 South 16th St., Philadelphia, Pa. Pamphlet, "A New Application of the 'Ritex' Process to the Manufacture of Chrome Brick," written by R. P. Heuer, director of research.

Pumps—Lawrence Machine and Pump Corp., 371 Market St., Lawrence, Mass. 4-page Bulletin No. 206 covering sewage and sludge pumps for horizontal and vertical drives, illustrates machines and installations.

Belts—Manhattan Rubber Mfg. Division, Passaic, N. J. 4-page Bulletin No. 6808-B, describes and explains details of construction of "Condor" compensated belt. Includes installation views and charts and diagrams containing technical data.

Bakelite—Synthane Corp., Oaks, Pa. 6-page folder describing and illustrating use of Synthane Laminated Bakelite for mechanical applications.

Roofing—Johns-Manville Co., 22 East 40th St., New York, N. Y. 22-page Catalog No. BU.-20A, gives complete details on line of roofing materials and methods, including numerous installation photos.

Porous Materials—Norton Co., Worcester, Mass. 20-page Bulletin No. 1246 describes uses and gives technical data on line of porous plates and tubes.

Controllers—Brown Instrument Co., Philadelphia, Pa. 24-page Catalog No. 8900, illustrates and describes line of air-operated controllers for temperature, pressure, flow and liquid level.

Welding — Harnischfeger Corp., Milwaukee, Wis. 24-page Bulletin HW-4, covers line of P&H-Hanson arc welders from 50 to 800- amp. units, as well as welding fixtures and accessories.

Welding—Lincoln Electric Corp., Cleveland, O. Two bulletins: No. 5M835, "Automatic Arc Welding by the Electronic Tornado," contains numerous photos of actual applications and tables of speed and cost data. Bulletin No. 20M-9-35, "Arc Welding Electrodes & Accessories," contains numerous photos of equipment and applications.

Heater—Ross Heater & Mfg. Co., Inc., 1407 West Ave., Buffalo, N. Y. Catalog No. 1046 gives description, drawings and dimensional and capacity tables for selecting fuel oil heaters and tank suction heaters for various services.

Electric Heating—Electric Air Heater Co. Division of American Foundry Co., Mishawaka, Ind. 24-page Data Book No. 236 illustrates and describes space heating by "Electromode" forced heat.

Maintenance—Stonhard Co., 401 N. Broad St., Philadelphia, Pa. 24-page illustrated guide for methods of keeping floors, roofs, walls and foundations in repair.

Coolers—Carbondale Machine Corp., unit of Worthington Pump & Machinery Corp., Harrison, N. J. 8-page Bulletin No. 1103 on horizontal, vertical, single-pass and multi-pass brine coolers.

Pumps—Lawrence Machine and Pump Corp., 371 Market St., Lawrence, Mass. 4-page Bulletin No. 208, illustrated, covers standard dredging pumps designed for pumping sand and gravel, ashes and cinders, and other applications where mixtures of water contain abrasive solids.

Valves—Hancock Valve Division, Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn. Two bulletins No. 7009-A, on "Flocontrol" valves manually operated with straight line flow characteristics. Other is 8-page bulletin which illustrates and gives all details on union bonnet bronze valves.

POWER LINES

Power Conference

Nations of the World have been invited by the State Department on behalf of the President to participate in and send delegates to the Third World Power Conference in Washington, D. C., September 7 to 12, 1936. "The National Power Economy" has been proposed as the subject for discussion. Plenary meetings of the conference are held every six years. First was in London in 1924, second in Berlin in 1930. William F. Durand has been appointed chairman of the conference and vice-chairman of the American Committee. Morris L. Cooke of the Rural Electrification Administration is Chairman of the committee in charge of planning and carrying out the conference.

Southern Show

Southern Industrial Show planned for Greenville, South Carolina, April 6 to 11, 1936, will include exhibits of machinery, boilers, engines, generators, power installation and other mechanical equipment.

Coal Law

A 15% tax on all coal produced in the United States with a 90% rebate to code members is the enforcement armament in the Bituminous Coal Conservation Act, the "Guffey Act" recently upheld by the Federal District Court in Louisville, Ky. Country is divided into nine minimum price areas, and 23 producing districts, each with a board subordinate to a commission of five appointed by the president. Each board has the authority to fix minimum prices and classify coals as to mines and markets.

New Russian Hydro Project

U. S. S. R. is ready to build its second great hydro-electric plant including a 2-mile dam across the Volga at Kamyshin, about 100 miles south of Sarator, and a power station with 26 60,000-kw. turbines, according to *Business Week*. By raising the river level 80 ft. it is planned to irrigate regularly more than 10 million acres. American equipment and advice will be contracted for, according to recent indications in Moscow.

Acetylene Assn. Meets in Cleveland

International Acetylene Association held its 36th annual convention at the Hotel Cleveland, Cleveland, Ohio, Nov. 12-15. Among papers were several of interest to power engineers, notably "High-Pressure Piping" by J. A. Freiday, mechanical engineer with Thos. E. Murray, Inc., which requires more extensive treatment than the limited space here available will permit, hence will be abstracted later in *Power*.

C. D. Abbott, district manager at Cleveland for Associated Factory Mutual Fire Insurance Co's., discussed "Prevention of Welding and Cutting Fires." His high points were: Where several welding stations are supplied from one central acetylene battery, a check valve should be installed at each station to prevent flash-backs, and blow-out disks piped to outdoors instead of relief valves at the hydraulic flash arresters and at several other points in the piping. Mr. Abbott explained that flash-backs in acetylene systems are quite rare nowadays, knowledge of the peculiarities of acetylene and safety precautions taken by makers of equipment having minimized the earlier difficulties. Portable sets, however, do not have as good a record, largely because they are convenient, hence are used carelessly, often where any open flame would be dangerous or where a spark might lodge and start a smolder which will not burst into flame for hours.

Mr. Abbott's records indicate that molten globules cause more fires than anything else. In the 200 fires during the last 3¾ years, 22 involved the equipment, resulting from leaky hose, backfires, leaky cylinder valves or bad connections at regulators, a few by overheating of the material being cut or welded. All the rest were caused by molten globules. Total loss was $213,000, ten fires causing $121,000 of the damage because they occurred in areas without sprinklers or with sprinklers shut off. It is particularly dangerous to use torches in buildings without sprinklers where there is combustible construction or occupancy. Tarpaulins or canvas should not be used for spark protection unless flameproofed; even then are not entirely satisfactory. Asbestos curtains are better, but sparks may pass over, roll under or find their way through openings at laps. The same criticisms apply to wood-board shields. Shields of metal or other incombustible material are satisfactory.

A primary requisite is to train operators and their managements regarding the dangers, and to allow no use of portable equipment without a permit from the plant engineer.

James Wilson, engineer with the Dept. of Commerce, mentioned in "Welded Piping and Pressure Vessels in the Marine Field" that one shipyard is now working on plans for a ship intended to operate at 1,200-lb. working steam pressure and 850 deg. F. total temperature, hence welding is almost mandatory. Several boilers and pressure vessels have been approved by the Bureau of Navigation and Steamboat Inspection and are working satisfactorily.

Dr. George V. Slottman presented a paper on "Hydrocarbon Fuel Gases for Cutting." Two reports, "Sample Pipe Welding Specifications," and "Tests for the Selection of Operators for Welding Equipment" were presented. All these can be obtained by addressing the Association at 30 East 42nd St., New York, N. Y., as can the papers on "Gas Welding of Class I Pressure Vessels" by G. W. Plinke of Henry Vogt Machine Co., and "Handling, Storage and Proper Control of Compressed Gas Cylinders" by F. R. Fetherston, secretary, Compressed Gas Mfrs. Ass'n.

NEWS NOTES

DEXTER P. COOPER has been awarded $60,000 for all rights, franchises, plans, data and equipment pertaining to the Passamaquoddy hydro-electric tidal development, by the War Department. According to the agreement, Mr. Cooper will furnish, without further consideration, consulting assistance and advice during planning and construction of the project, and thereafter until it is in operation.

INVITATIONS to compete for the Charles A. Coffin medal for 1936 are being extended this month by the Prize Award Committee of Edison Electric Institute, 420 Lexington Ave., New York, N. Y., to all electric light and power companies operating in the U. S. Award will go to company which, during 1935, made the most distinguished contribution to the development of electric light and power for convenience of public and benefit of the industry. Presentation will be made at 1936 Convention of the Institute. In addition to the medal, the award carries a gift of $1,000 for employees benefit fund of winning company.

AMERICAN STANDARDS ASSN., 29 West 39th St., New York, N. Y. is about to undertake a new dictionary of letter symbols and abbreviations "The Language of Engineers and Scientists." Any group which has published its own standard for symbols is urged to submit a copy to the committee. Dr. J. Franklin Meyer. National Bureau of Standards, Washington, D. C., has been appointed chairman of the committee.

AN ANALYSIS by Dean Parker H. Daggett of Rutgers College of the provisions of 35 state registration laws for engineers is contained in the 1935 Annual Report of the Committee on Professional Recognition of the Engineers' Council for Professional Development, 29 West 39th St., New York, N. Y., to be printed soon.

NEW ENGLAND POWER ASSN. employees achieved a new record this fall by working 1,250,000 man-hours without a single accident resulting in time out from work. This was done without any incentive other than achieving the record. The system has about 1,532 employees.

METHODS for determining dustiness of coal will be investigated by a subcommittee of the American Society for Testing Materials, 260 South Broad Street, Philadelphia, Pa. The subcommittee intends to recommend a standard test method to enable producer or consumer to test efficiency of anti-dust treatment.

FURNACES and boilers of every type and for every fuel, as well as unit heaters and central heating systems, will be on display at the Fourth International Heating & Ventilating Exposition to be held in International Amphitheatre, Chicago, Ill., Jan. 27-31, 1936. Hot-water heaters, both separate and for use

with main heating plants will be demonstrated. A large section will be devoted to air conditioning and accessories. Refrigeration and insulation materials will be well shown.

OBITUARIES

ROBERT CHELSTROM, 59, New England representative of Oster-Williams, Cleveland, Ohio, was killed in an automobile accident Oct. 18.

MICHAEL F. COX, 76, retired chief engineer, Elks Home, Providence, R. I., died Nov. 11.

GORDON E. HASLAM, 62, head of Haslam Heating & Ventilating Co., Providence, R. I., died November 15.

ALEXANDER G. MILLIKEN, 47, Boston stationary power engineer and former naval officer, died Nov. 12.

BENJAMIN E. ROBBINS, 64, president of Robbins Phalon Co., Boston, Mass., sales representatives of Dayton Pump & Manufacturing Co., Dayton, Ohio, died Nov. 7.

PERSONALS

EDMUND BURKE has been appointed manager of industrial sales for Crane Co., Chicago, Ill. Mr. Burke has been with the company since 1910. W. Howard Pape succeeds Mr. Burke as manager of sales.

ARTHUR A. ARANSON, formerly of the International Harvester Co., has been appointed assistant to the president of Crucible Steel Co. of America, 405 Lexington Ave., New York, N. Y.

GEORGE E. CLIFFORD has been appointed district sales manager of Republic Steel Corp. in Los Angeles, Calif., district, following the resignation of George F. Emanuels. Mr. Clifford was formerly with A. M. Byers Co.

R. H. GARDNER, formerly Washington division manager for A. M. Byers Co., has been transferred to Pittsburgh. Simultaneously, E. L. MacWhorter, former manager of Philadelphia division, moves to Munsey Building in Washington, where he will head the Washington division.

HENRY W. FOULDS has been elected vice-president of The Permutit Co., New York, N. Y., to correlate and direct all sales, promotion and advertising.

E. A. HANCOCK has been appointed district manager, industrial department, New England district, of General Electric Co., succeeding C. A. Chase, who retired October 31.

JOHN F. HANBURY has been appointed manager of New York office of Warren Webster & Co., at 470 Fourth Avenue, succeeding the late William M. Treadwell.

CHARLES MACLENNAN, former load forecaster and system operator at Millbury, Mass., headquarters of New England Power Co., and previously with Brooklyn Edison Co., is now engaged in power sales for Tata Power Co., Ltd., Bombay, India.

OTTO DE LORENZI has been appointed assistant general sales manager of Combustion Enginering Co., Inc., New York, N. Y. Except for two years in the American Expeditionary Forces, Mr. de Lorenzi has been with the company since 1916.

BUSINESS NOTES

AUTOMATIC TEMPERATURE CONTROL CO., Philadelphia, Pa., has appointed Carman Adams, Inc., 2970 West Grand Boulevard, Detroit, Mich., Stewart N. Miller, 179 Melrose Ave., Needham, Mass., and Fred I. Tourtelot Co., 20 East Jackson Boulevard, Chicago, Ill., representatives.

THWING-ALBERT INSTRUMENT CO., is the new name of Thwing Instruments Co., Philadelphia, Pa., produced by adding the name of Edward J. Albert, manager and secretary of the company for seventeen years.

KENNEDY VALVE MFG. CO., Elmira, N. Y., has appointed Frank De Witt & Co., 5736 Twelfth St., Detroit, Mich., representatives in the lower peninsula.

ALUMINUM INDUSTRIES, INC., Cincinnati, Ohio, Paint Division, has appointed C. L. Welch, Lee S. Abbott and George E. Fox, district managers.

WORTHINGTON PUMP & MACHINERY CO., Harrison, N. J., has authorized construction of an additional machine shop building at its Buffalo, N. Y., works. Extension to cover floor area of 75,000 sq.ft. Building to be ready for occupancy about first of 1936.

LINCOLN ELECTRIC CO., Cleveland, Ohio, has opened two new offices, at 923 South Washington St., Peoria, Ill., under direction of W. I. Miskoe, and at Memphis, Tenn., under O. B. Farrell. Lewis S. Hinchman has been transferred to the Chicago district sales office at 1455 West 37th St. Paul M. Corp has entered the Milwaukee office, and E. H. Weil has been transferred to the San Francisco sales personnel.

METAL SPRAY CO., has been reorganized as Metalspray Co., Inc., at 113 Llewellyn St., Los Angeles, Calif. J. C. Martin, Jr., has been elected president.

ALBERT C. WOOD and Alton Kirkpatrick, consulting engineers have opened offices in the Stock Exchange Bldg., 1411 Walnut St., Philadelphia, Pa. under the name of Wood & Kirkpatrick.

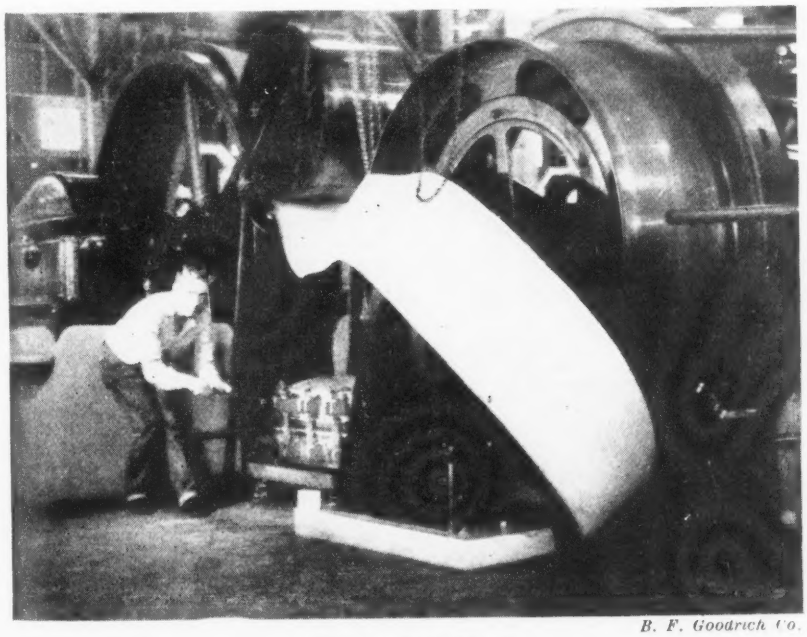
HARRY T. PORTER, 2436 Reading Road, Cincinnati, Ohio, has been appointed representative for Cincinnati and vicinity by American District Steam Co., North Tonawanda, N. Y.

TITUSVILLE IRON WORKS CO., Titusville, Pa., has moved its New York office to the 43rd floor of the R.C.A. Bldg., 30 Rockefeller Plaza, New York, N. Y.

ELECTRICAL SURVEY AND ENGINEERING CORP., 424 Madison Ave., New York, N. Y., has elected Alfred Helwig president and chief engineer, following resignations of Warner J. Sherb, former president and Harry P. Wood, former chief engineer.

HARRIS-GREEN CO., Farmers Bank Bldg., Pittsburgh, Pa., has been appointed district sales agent for western Pennsylvania, eastern Ohio and West Virginia, for Roller-Smith Co., 233 Broadway, New York, N. Y.

COMBUSTION ENGINEERING CO., INC., 200 Madison Ave., New York, N. Y., has appointed Wilson Machinery & Supply Co., Inc., Lexington, Ky., and William Franklin, Buffalo, N. Y., as representatives of its industrial stoker division, and Industrial Combustion Co., Allegheny Ave. and Boudinot St., Philadelphia, Pa., as representative in southeastern Pennsylvania, southern New Jersey and Wilmington, Del.



B. F. Goodrich Co.

FOUR HOUR SPLICE

22-inch, 6-ply endless belt on the pulleys of a large gas compressor was spliced in four hours and ready for immediate operation. Splice was made by cutting ends of belt in bias steps so that ends of plies interlocked, then countersunk beneath belt surface. Resulting depression was filled with reinforced rubber cushion and vulcanized to hold end of plies in position, preventing them from working loose. Vulcanized by special portable electric vulvanizer, shown.

STRAWS

Pointing the way business winds blow

South and Southwest

CHARLESTON, S. C., has awarded a construction contract for the $37,500,000 Santee-Cooper power and navigation project to Parsons, Klapp, Brinckerhoff and Douglass, New York, N. Y. PWA has designated Capt. J. L. M. Irby, state PWA director at Columbia, to be public works officer in charge of project.

VIRGINIA ELECTRIC & POWER CO., Williamsburg, Va., has installed a York refrigerating system which provides 38.3 tons of refrigeration for ice-making and air-conditioning, and in addition heats the building in winter by reversing the refrigeration cycle as a heat pump.

APPALACHIAN ELECTRIC POWER CO., Roanoke, Va., has authorized extensions and improvements in steam-power plant at Logan, W. Va., to be carried out early next year. A new 40,000-kw. G.E.-type turbine-generator will be installed, with other equipment. Project to cost over $3,000,000. Company under direction American Gas & Electric Co. The 1,250-lb. 925-deg. steam turbine and generator is the largest 3,600 r.p.m. machine ever built. Generator will be hydrogen cooled. Installation of main unit and auxiliaries to be completed in 1937.

HOPKINTON, IOWA., closes bids Dec. 10 for equipment for proposed municipal electric plant, including two diesel units, fuel oil tank, switchboard and complete auxiliary equipment. $67,800 arranged. A. S. Harrington, Baum Bldg., Omaha, Neb., consulting engineer.

HOUSTON NATURAL GAS SYSTEM, INC., Houston, Tex., plans welded steel pipeline from natural-gas field to Port Lavaca, Tex., and vicinity, where commercial gas will be furnished by Texas Natural Gas Utilities, Inc., affiliated interest. Distribution system will be installed. Project will cost over $100,000. Frank C. Smith is the general manager.

LOWER COLO. RIVER AUTHORITY, Bluffton, Llano County, Tex., has work under way on proposed hydro-electric power project on the Colorado River, near Bluffton, where site was recently secured from Colorado River Co., including a partially completed dam. Financing necessary $20,000,000.

ARCHER HOSIERY MILLS, Columbus, Ga., have plans for 1-story addition to steam power plant in connection with other expansion at knitting mills, entire project estimated to cost over $80,000. Work to begin soon. Lockwood, Greene Engineers, Inc., Spartanburg, S. C., consulting engineer.

FORT PIERCE, FLA., plans municipal power plant to include 2,500-kw. turbine-generator and auxiliary equipment. To proceed soon.

HOMINY, OKLA., has secured low bid from Chicago Pneumatic Tool Co., Chicago, Ill., for three diesel-generating units and accessory equipment for municipal power plant. Financing through Federal aid. Low bid for building and electrical system tendered by Mattison-Wallack & Co., Key Bldg., Oklahoma City, Okla. Awards expected in near future. V. V. Long & Co., Colcord Bldg., Oklahoma City, Okla., consulting engineers.

East

PLATTSBURG, N. Y., is completing plans for municipal power plant, and distribution lines, estimated to cost $550,000, and will begin work in near future. Burns & McDonnell Engrg Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

DEPT. OF INTERIOR, U. S. Indian Service, Washington, D. C., has awarded contract to Industrial Heating & Engrg. Co., Milwaukee, Wis., for power plant at reservation, Navajo Capital, N. M., at $56,632.

WILMINGTON, N. C., will soon take bids for pumping machinery and auxiliary equipment for municipal water station, including high-lift 4,000-g.p.m. centrifugal unit, oil or gas-engine-driven, and for 800-g.p.m. low-lift pumping unit of same type. Dept. of Public Works in charge.

VISCOSE CO. OF AMERICA, INC., Marcus Hook, Pa., soon takes bids for new power house at rayon mill. Cost over $600,000. Ballinger Co., 105 South Twelfth St., Philadelphia, Pa., architect and engineer.

ARCADE, N. Y., has approved municipal electric plant, including installation of new diesels and accessories to replace present steam equipment. $80,000 authorized.

BUREAU OF YARDS & DOCKS, NAVY DEPT., Washington, D. C., has contracted with Ideal Electric Mfg. Co., Mansfield, Ohio, for four 600-kw. motor-generator sets, switchboards and accessories for Mare Island, Calif., Navy Yard, at $99,872.

CAMDEN, N. J., has authorized construction of municipal electric plant and plans will be arranged at early date. Plant to cost $10,000,000 and will include facilities for central steam heating in business section. Site selected near foot of Spruce St. on Delaware River. Frederick von Nieda, mayor.

Midwest

BURLINGAME, KAN., soon takes bids for municipal power plant. Fund of $51,200 through Federal aid. Black & Veatch, 4706 Broadway, Kansas City, Mo., consultants.

BEMIDJI, MINN., is considering new municipal power plant, reported to cost over $100,000, and will arrange financing through Federal aid. Burlingame & Hitchcock, Sexton Bldg., Minneapolis, Minn., consultants.

MICHIGAN BREWING CO., Grand Rapids, Mich., has let contract to Wickes Boiler Co., Saginaw, Mich., for three 1,750-sq.ft. oil-fired boilers with auxiliary equipment for power house at new brewery.

SPRINGFIELD BREWING CO., Springfield, Ohio, has plans maturing for remodeling and improving former Home City Brewing Co., to include boiler plant. Entire project will cost about $75,000. Konrad Keil, 1215 Windsor Drive, Dayton, consulting engr.

MANKATO, KAN., is arranging early special election to vote bonds for $110,000 for proposed municipal electric power plant and electrical distributing system. Proposed to begin work early in 1936. E. T. Archer & Co., New England Bldg., Kansas City, Mo., consulting engineers.

EMPIRE PACKING CO., 3840 Emerald St., Chicago, Ill., filed plans for addition to steam power house, to cost about $25,000, and will proceed at once. L. F. Coleman, 453 Sixty-third St., architect.

WAUKON, IA., voters defeated a proposal to issue bonds for the construction of a municipal light plant to cost $175,000.

CENTRAL MICHIGAN PIPELINE CORP., Mount Pleasant, Mich., James D. McKay, head, recently formed, has plans for new welded steel pipelines from local natural-gas fields to Clare, Rosebush and vicinity, for commercial gas service. Cost reported over $90,000. Permission granted.

WESTERN MICH. PIPE LINE CO., Grand Rapids, Mich., Joseph H. Brewer, Pres., has applied for permission to construct new 12-in. welded steel pipeline from natural-gas properties in Montcalm and Mecosta Counties to Grand Rapids and vicinity, for commercial gas service. Similar system planned at Greenville, Mich. Cost about $875,000.

SMITH, HINCHMAN & GRYLLS, Marquette Bldg., Detroit, Mich., architects and engineers, plan 1-story steam power plant for ale brewery to be constructed at Northville, Mich., by company being organized. Site acquired. Project will cost close to $85,000.

SANDUSKY, OHIO, plans electric power plant. City commissioners elected recently pledged to project. Estimates of cost being made.

WINSTED, MINN., has engaged Banister Engrg. Co., 556 North Prior Ave., St. Paul, Minn., consulting engineer, to prepare plans for municipal electric plant and proposes to begin work soon. Cost about $85,000.

HAIGLER, NEB., has approved bond issue for electric power plant, and plans for station will be drawn soon. Cost about $40,000. Work to begin early next year.

INTERNATIONAL HARVESTER CO., Chicago, Ill., plans steam power house at plant on Lagonda Ave., Springfield, Ohio, and will begin work soon. Cost about $150,000. W. H. Kruger, company engineer, Chicago headquarters.

NEW ULM, MINN., is considering improvements in municipal power plant, to include steam turbine-generator, superheater and auxiliary equipment. Cost about $90,000. Ralph D. Thomas, 1200 Second Ave., S., Minneapolis, Minn., consulting engineer.

CINCINNATI, OHIO, will soon take bids for four electric pumping units and auxiliary equipment for new waterworks. Cost about $175,000. Waterworks department, Albert Hibbs, supt. Fosdick & Hilmer, Union Trust Bldg., consulting engineers.

WHITE CLOUD, MICH., has engaged Williams & Works, Grand Rapids, Mich., consulting engineers, to plan improvements in power plant, with new equipment for increased capacity. Cost about $45,000. Bids soon.

LAKE CRYSTAL, MINN., is having surveys and estimates of cost completed by Power Engrg. Co., Metropolitan Life Bldg., Minneapolis, Minn., consulting engineer, for proposed municipal power plant, using diesels, and plans to proceed with work early next year.

CITY OF MINDEN, Nebraska, which, in 1934, purchased a five-cylinder, high-speed, 375-hp. diesel engine, will soon buy a 600 to 750-hp. diesel, as an alternate for the model rural electrification project in Kearney County. Project will first depend on Tri-County Irrigation and Power project for power, but at times it will be necessary to receive power from another source. It is reported that in 1934 the city produced and distributed 958,740 kw. at a cost of $5,306.81.

EXIRA, IA., has received approval of a $33,750 grant for a $75,000 power plant.

ELECTRIC AIR HEATER CO., division of American Foundry Equipment Co., 555 Byrkit St., Mishawaka, Ind., has received an order for 33 of its 4-kw. heaters for use in submarines being built by the Electric Boat Co. for the U. S.

West Coast

SAN DIEGO, CALIF., plans early bids for about 4 miles of 48-in., and 2 miles of 36-in. steel pipe, for main water supply line from El Capitan Dam, connecting with present pipeline running from Lakeside to University Heights. Financing of $430,000 arranged. Fred D. Pyle, city hydraulic engineer, in charge. In conjunction with this line, La Mesa Irrigation District, La Mesa, will build an upper section of about 2 miles of 48-in. steel pipe, for which bids will be asked separately about the same time by the District, for which C. Harritt is general manager and chief engineer. All pipe sections for entire line will be treated inside and outside with coal tar coating, or spun cement lining and gunite exterior coating, as called for in specifications.

P. J. BURK CANNING CO., Milton, Ore., plans 1-story boiler plant in connection with new 2-unit fruit-canning plant on local site, and will begin work soon. Cost close to $100,000.

PENNZOIL CO., Los Angeles, Calif., has let contract to Stanton-Reed Co., 816 West Fifth St., for new lubricating oil compounding and distributing plant on East 26th St., Vernon, near Los Angeles. A 1-story power house will be built. Entire project will cost close to $100,000. Llewellyn A. Parker, Architects' Bldg., Los Angeles, architect.

SACRAMENTO, CALIF., has voted bonds for $465,000, to which a Federal grant of $381,630 will be added, total of $846,630 for extensions and improvements in municipal water supply, including new electric-operated pumping equipment, two overhead steel storage tanks, reservoir, etc. Water Department in charge; early date.

BOARD OF WATER COMMISSIONERS, Long Beach, Calif., soon takes bids for construciton of battery of six steel water-storage tanks for municipal system in Alamitos Hill district, each tank to be 132 ft. in diameter and 35 ft. high, formed of steel plate from $\frac{1}{4}$ to $\frac{7}{8}$-in. thick, with capacity of 3,440,000 gals., or total rating of 20,640,000 gals. Cost estimated at $266,000. Fred F. Porter, general manager and chief engineer of Water Department.

ALAMEDA, CALIF., will soon take bids for 2-story sub-station for electric lighting plant and complete equipment. Cost close to $200,000. Engineering dept., William R. Paulson, chief engineer.

SO. CALIF. GAS CO., 950 South Broadway, Los Angeles, Calif., has approved plans for new welded steel pipeline in Fresno and Kings Counties for gas service, and will proceed with work soon. Another steel pipeline will be constructed between Tulare and Visalia, Calif., for similar purpose. Entire project will cost about $100,000.

HARRY N. JENKS, 2701 Benvenue Ave., Berkeley, Calif., consulting engineer, representing irrigation and sewage reclamation project being organized near Santa Ana, Calif., has preliminary plans for main reclamation plant, with 3,000,000-g.p.d. electric-operated pumping equipment. Standby power plant using gas-engine generating units will be built. Project estimated to cost $835,000.

SAN JOSE, CALIF., plans diesel power plant for standby service for four new emergency waterworks pumping stations of large capacity. Project estimated to cost $2,700,000. W. L. Popp, city engineer, made surveys and estimates of cost.

Foreign

ROTTERDAM, HOLLAND, has completed its electric power plant equipped with two 84,000-kw. British turbo-generators. Space has been provided so that normal capacity of plant can be increased to 220,000 kw. Steam is derived from four pulverized-coal-fired boilers rated at 100 tons per hour.

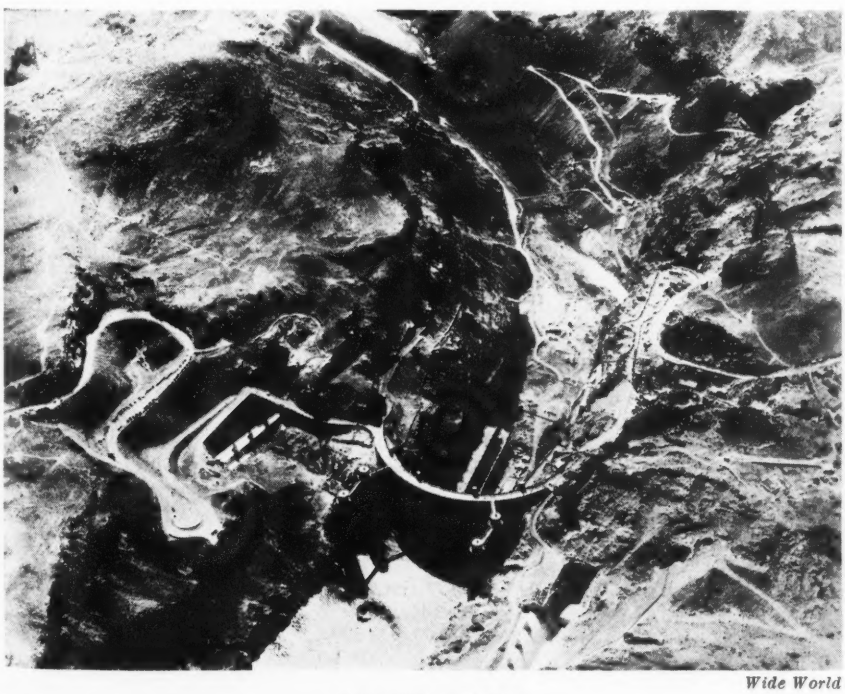
SWEDISH WATER-POWER ASSN. reports that the total fully developed water-power in Sweden at the beginning of this year was 1,418,000 kw., corresponding to 1,930,000 hp. Since 1929 turbines have increased by an annual average of 45,000 kw., or 4%. Partly developed water-power is estimated at 122,000 kw., or 166,000 hp.

VANCOUVER, B. C., City Council has been instructed to make special effort to find $75,000 for renovation of the General Hospital heating and power plant. Council was told that hospital boilers are over 30 years old and liable to break down, besides being inadequate and uneconomical.

REGINA, SASK., has plans for improving municipal power plant, to include new turbine-generator unit and auxiliary equipment, high-pressure boilers, pumps and other equipment. Bids at early date. Cost in excess of $500,000. E. W. Bull, chief engineer and superintendent.

NORTH LOUP HYDRO-ELECTRIC AND IRRIGATION PROJECT, Ord., Neb., has concluded financing through Federal aid of $2,117,000 for proposed hydro-electric power and irrigation project for which plans are being drawn by Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers. Project will include main station at the mouth of Gravel Creek, where power dam 40 ft. high and 400 ft. long will be built. Another station for emergency service will be near Sioux Creek.

CANADIAN WESTERN LUMBER CO., Fraser Mills, near New Westminster, B. C., plans $100,000 expansion program, including installation of veneer dryer, construction of conveyor system to take refuse from shingle mill to company's main power plant, and addition of a 450-hp. boiler to increase power plant capacity.



Wide World

DAM NEAR DONE

Air view of Boulder Dam and surrounding country from behind the dam. Intake towers in foreground; power house behind dam.

WEAK LINK . . .

ONCE, several years ago, I said in *Power* that I wished somebody would invent a "need clock" that, instead of ticking, would drop a card in my hand when I realized that I needed something, the card carrying the words, "Need *X* has continued eight months, three days and four hours because you were too blind to see it. At $3.50 per day, your total loss is $851.06." And then that clock would go right on ticking until the need was filled—the waste stopped. It would then hand me another ticket stamped: "You lost $851.06 because you didn't know any better. For an additional six months, seven days and eight hours, during which you willfully let things slide, the bill is $655.66. Total $1,506.72."

Well, I've got something like it working—a "must sheet." I put on it what equipment I've got to have now, and what I've got to have to carry certain added loads, with costs and my figures on savings. The things on it I "must" have for two reasons, first to protect me from criticism on my job, and second, to protect the Boss! His production plans are always based on power—a certain amount he'll need at a certain time, and I don't want power to be the weak link.

So, every so often, I look at my "must sheet," then drop a note on the Boss' desk that says something like this: "Three months ago I said I must have a steam meter. You said, "No money. It would have cost $400. Well, so far we've lost $100 because we didn't get it."

It used to take about three notes before the Boss relaxed his grip on the money bags. It has been better lately, because the Boss checked up on me and found that what I told him was right—in fact that I was conservative. So the first note did it last time. He realizes now that just because the plant runs doesn't prove that it couldn't run better.

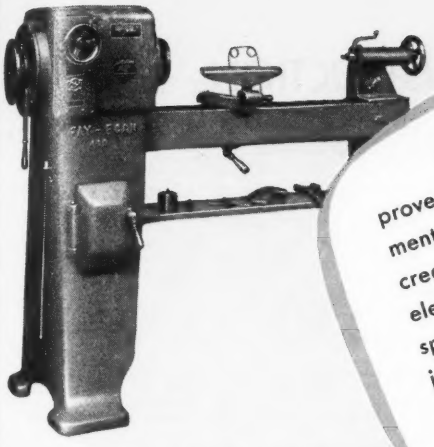
I think it was Schwab who once reported to Carnegie that a new steel plant costing some millions of dollars had just been finished, but that a new process of steelmaking had already rendered it out of date. "All right," rejoined his canny employer, "Tear down the plant and rebuild it!"

That plant had never made a ton of steel—but Carnegie knew that if he put it to work, every ton of steel it did make would cost him more than it ought to, that it would pay him in the long run to get his plant up-to-date right away.

I'm a conservative, but so many business indexes have been turning up that I'm convinced we're on the way back. That means more load, more demands for steam and power. If you get stuck for power, the local utility can help out (for a price), but utilities don't supply steam. If you need steam and haven't got it, what then? The only answer is my "Must Sheet" and the notes every little while—"Boss, you'll be wanting more steam in Number Six in a month or two. We're putting out all we can now, so what? A new boiler ordered now will save you blank dollars in six months." If he's smart, he'll get the idea. If he doesn't, you'd better find a Boss who does.

George Edwards

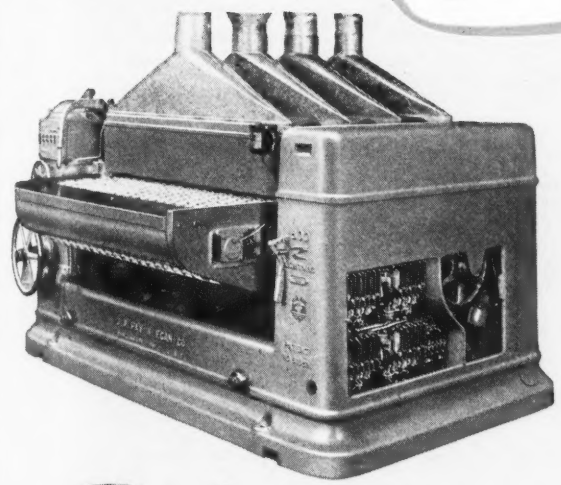
GEORGE EDWARDS
Engineer

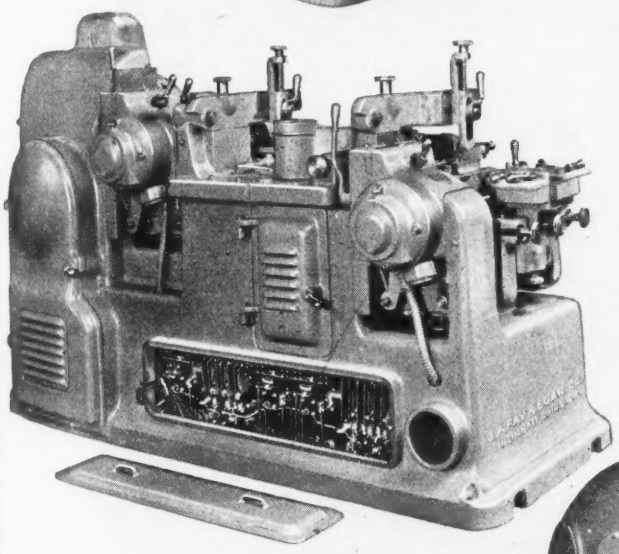


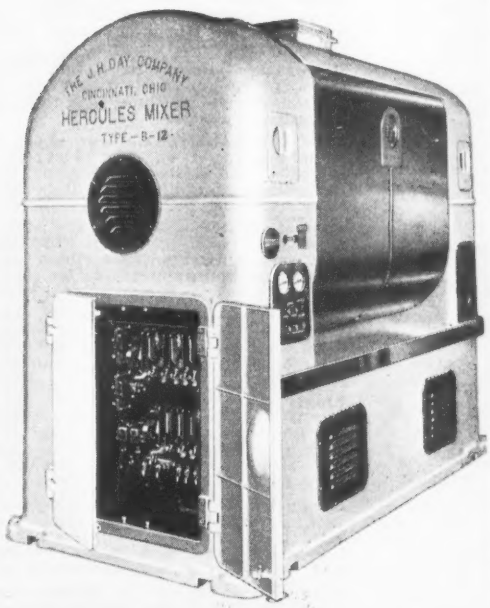
"Observation at the Machine Tool Show proves clearly that the two outstanding developments in design of machine tools are the increasing use of motors and the building-in of electrical controls. *** That these trends will spread quickly to other types of machinery is just as inevitable as was the spread of the idea of designing for appearance as initiated by the automobile industry."

TO BUYERS OF *Machinery*

This statement made by a leading magazine in the machine tool field, after the recent machine tool show at Cleveland, is food for thought for any executive. *To be sure of buying modern machines, judge by the Motor Control.* Keen builders of machines for every purpose from Air Conditioning through the alphabet to Woodworking are *already* featuring "built-in" Cutler-Hammer Motor Control. Such machines *are* modern . . . definitely better . . . for they add the economies of correctly applied *good* Motor Control to all other savings made. More and more machine builders are consulting Cutler-Hammer engineers before new designs leave the drafting board. Watch the rising tide of "Cutler-Hammer Motor Control is standard equipment." CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus,* 1358 St. Paul Ave., Milwaukee, Wis.







Shown above are three types of woodworking machines and, at the right, two models of bakery machines which feature "built-in" Cutler-Hammer Motor Control. They typify the complete, truly modern designs available today for every type of business. It's more than a trend . . . it's a tidal wave to Cutler-Hammer Motor Control.

CUTLER-HAMMER MOTOR CONTROL

STARTS ★ STOPS C-H REGULATES ★ PROTECTS

NEW BULLETINS

Belt Preservatives—E. F. Houghton & Co., 240 West Somerset St., Philadelphia, Pa. 12-page folder contains helpful information on how, when and why to use belt preservatives or dressings and describes various kinds.

Gas Testing Apparatus—American Meter Co., Inc., 60 East 42d St., New York, N. Y. Catalog AG-2 made up of bulletins AG-1 to AG-6 describing and illustrating meter provers, calorimeters, recording and indicating demand meters, gages, service cleaners, etc.

Humidistats and Controls—Julien P. Friez & Sons, Inc., Baltimore St. & Central Ave., Baltimore, Md. Two bulletins, "A" illustrates and describes wall-mounting and insertion type Humidistats and "AT/R" on relays and control assemblies for use with Humidistats, thermostats, etc.

Pumps—American Engrg. Co., Philadelphia, Pa. 44-page illustrated catalog gives charts, tables. drawings, data and uses for pumps, hydraulic motors, transmissions, regulators, differential valves and pipe-testing machines.

Lubrication—Alemite Corp., 1826 Diversey Parkway, Chicago, Ill. 25-page catalog shows equipment, details, specifications and prices for lubrication equipment.

Pumps — Lawrence Machine & Pump Corp., 371 Market St., Lawrence, Mass. Bulletin No. 203 illustrates acid and chemical pumps and their capacities and heads.

Nickel Cast Iron—International Nickel Co., Inc., 67 Wall St., New York, N. Y. 12-page bulletin gives properties and applications of nickel-alloy cast irons.

Diesel Engines — Cooper-Bessemer Corp., Mt. Vernon, Ohio. 12-page illustrated folder describes line of 25 to 110-b.hp. single- and twin-cylinder horizontal diesels for stationary service and for small power user.

Thermit Welding—Metal & Thermit Corp., 120 Broadway, New York, N. Y. 16-page illustrated pamphlet No. 18b gives principles, properties and costs of thermit welding.

Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. 8-page illustrated booklet covers deep-well turbine pumps including construction, sizes, capacities and applications. No. W-450-B17A.

Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. Illustrated bulletin No. W-316-B3, 8 pages, gives details of construction, types of drives, and applications for line of vertical drainage pumps.

Directory—Stewart Printing Co., 632 Sherman St., Chicago, Ill. 338-page annual edition of "Engineers' Power Plant Directory and Buyers' Guide." Lists steam, electric and refrigerating plants with names of engineers and other executives in charge; classified guide of equipment and supplies for use of engineers and buyers; directory of officials, etc.

Steel—Lukens Steel Co., Coatesville, Pa. 16-page leaflet illustrated with portraits and etchings traces 125-year history of company.

Respirators—Pulmosan Safety Equipment Corp., 176 Johnson St., Brooklyn, N. Y. 3 folders describing line of respirators for hazardous locations.

Air-Conditioning Equipment—York Ice Machinery Corp., York, Pa. 6 sheets on 10-, 15-, 20-, and 25-hp. condensing units for refrigeration and air conditioning and series of horizontal-type air conditioners.

Control Systems—Taylor Instrument Co., Rochester, N. Y. Bulletin 37R, 36 pages, profusely illustrated, describing operation, accessories and applications for certain control systems.

Refractories—M. H. Detrick Co., 140 South Dearborn St., Chicago, Ill. 15-page, well-illustrated booklet gives complete information for type of boiler arch and wall construction.

Floats—W. H. Nicholson & Co., 213 Oregon St., Wilkes-Barre, Pa. 4-page bulletin No. 635 illustrates and details series of welded steel (chromium-plated) and welded stainless steel floats for steam traps, water columns, tanks, float valves, etc.

Expansion Joints — Direct Separator Co., Inc., Syracuse, N. Y. 22-page loose-leaf catalog No. EJ-35. Complete data including prices and dimensions of internally and externally guided expansion joints.

Purge Drum—York Ice Machinery Corp., York, Pa. Sheet No. SP-35250 gives complete information on thermostatic purge drum for elimination of air and non-condensable gases in refrigerating system.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ala., Russellville—Bids Dec. 5, by Municipality, for electric power plant.

Calif., Palo Alto—City, estimates of costs submitted for Diesel electric generating plant, 6,000 kw. capacity, $550,000; constructing 7,500 kw. capacity steam generating plant. $838,000. P.W.A. allotted $218,100 grant. L. S. Ready, Rialto Bldg., San Francisco, engr.

Calif., Whittier—City plans special election Nov. 26, to vote $370,000 bonds to assist in financing construction of municipal light plant. Est. $662,000. P.W.A. approved $292,000 grant. D. E. Allen, city clk.

Colo., Delta — City Council, voted charter amendment Nov. 5, authorizing construction of municipal light and power plant. $196,000. E. C. Porter, Wilda Bldg., Denver, engr.

Ga., Milledgeville—State Bd. of Eleemosynary Institution, Capitol Bldg., Atlanta, plans heating and light plant for state farm, incl. steam boilers, generating plant distribution lines, steam and power. $350,000. Comer Turley, c/o Lindale Mills, Lindale, engr.

Ia., Hopkinton—Bids Dec. 10, by City Council, constructing municipal electric light and power plant, incl. 2 Diesel generator units, 150 hp., 200 hp., and auxiliary equipment, switchboard, electric distribution system, etc. $68,000. $30,000 P.W.A. grant allotted. A. S. Harrington, Baum Bldg., Omaha, engr.

Kan., Mankato—City defeated bonds for power plant. $100,000. E. T. Archer & Co., 609 New England Bldg., Kansas City, Mo., engrs.

Ky., Danville—City, made application to P.W.A. for $350,000 loan and grant to construct municipal light and power plant.

Me., Skowhegan—State, Augusta, plans by A. J. Thayer, Auburn, steam power plant and laundry at Women's Reformatory. $65,000.

Mass., Worcester—City, at office of Mayor, City Hall, plans completed by Stevens, Curtin & Mason, 45 Newbury St., Boston, 20x50x30 ft., structures for power plant addition, at City Hospital, incl. three 250 hp. boilers with settings, mechanical and auxiliary equipment and mechanical oil burning system. $57,000. G. Adolph Johnson, 16 Norwich St., Worcester, assoc. archt. E. J. Tucker, City Hospital, superv. engr.

Minn., Winsted — Village plans municipal light and power plant. Banister Eng. Co., 556 North Prior Ave., St. Paul, engrs. $85,000.

Mo., Kirksville—City, A. L. Bartlett, mayor, plans municipal light and power plant system. $640,000. P.W.A. allotted funds. Black & Veatch, 4706 Bway., Kansas City, engrs.

Neb., Cambridge—United Power & Irrigation Dist. plans power and irrigation project, incl. small power plant. $945,000. P.W.A. application to be filed. C. Mickey, Lincoln, engr.

Nev., Las Vegas—City plans municipal power plant. $250,000. Will call bond election of $250,000 to finance project. B. Dibble, Denver, engr.

N. Y., Albany—City voted $10,000,000 and authorized mayor to appoint commission with authority to issue bonds and either construct new plant or acquire existing power plant facilities.

N. Y., Albany—Albany Co. voted $25,000,000 for constructing county power plant.

N. Y., Arcade — Bd. Village Trustees special election Oct. 16, approved $80,000 for purchasing and installing Diesel engines to replace steam equipment at municipal light and power plant. $80,000. **Maturity at once.**

N. Y., Croton—Town making plans hydro-electric plant. $350,000. Applied for P.W.A. grant. W. Whitman, c/o owners, engrs.

N. Y., Lockport—Bd. Commerce received report from P. J. Loftus Eng. Co., Oliver Bldg., Pittsburgh, that municipal hydro-electric plant will cost $375,000 in excess of $1,800,000 claimed by supporters of project. Bonds defeated.

N. Y., Ludlowsville—Lansing Twp. making plans constructing hydro-electric plant. $350,000. Applied for P.W.A. grant. W. Whitman, c/o owner, engrs.

N. Y., New York — New York University, School of Engineering, University Heights, C. P. Bliss, dean, plans 3 story, steam electric power plant and laboratory, 180th St. and University Ave. $400,000. Project now financing.

N. Y., Rochester—Rochester Gas & Electric Corp., 89 East Ave., making plans steam turbine generating plant near Station 3. $1,000,000. E. M. Gilbert, 512 Washington St., Reading, Pa., engr.

N. D., Crosby—Municipality plans electric power plant, distribution system. $100,000. I. R. Atkinson, Bismarck, engr.

O., Niles — City making final plans power plant improvements. $750,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

O., St. Marys—City plans addition to municipal light plant. $220,932. Applied for P.W.A. funds. C. J. Simon, Van Wert, engr.

O., Shelby—City, B. Fix, clk., plans light plant addition. $120,000. Froelich & Emery Eng. Co., 2nd National Bldg., Toledo, engrs. Application made to P.W.A. for funds.

O., Warren—Ohio Public Service Co., T. O. Kennedy, genl. mgr., sketches 35,000 kw. turbine, new boilers for power plant extensions. $2,000,000. Owners Engineering Dpt., engrs.

Pa., Marcus Hook—Viscose Co., plans by the Ballinger Co., 105 South 12th St., Phila., power house, incl. turbines and generators, Post Rd. $1,225,000.

R. I., Burrillville—State, Emergency P. Wks. Comn., State House, Providence, making plans power plant, at State Sanatorium. $172,600. P.W.A. grant $77,670. Jenks & Ballou, 2600 Industrial Trust Bldg., Providence, engrs.

S. D., Beresford—City, W. F. Smith, aud., plans complete municipal electric light and power plant. $71,000. P.W.A. allotted $23,250.

Tex., Childress—City, c/o C. M. Crawford, filed application with P.W.A. for loan and grant to finance construction light and power plant. $200,000. J. E. Ward, Wichita Falls, engr.

Tex., Dennison—Red River Power Dist., c/o Rivers & Harbor Div., Galveston, and Wash., D. C., plans constructing power dam project on Red River, near here. $2,500,000. Funds assured for immediate survey.

Tex., Leonard—City, B. D. Ewing, mayor, plans municipal electric light and power plant, underground distributing lines, etc. $75,000. P.W.A. funds allotted. J. E. Ward, Harvey-Snider Bldg., Wichita Falls, engr.

Tex., Lubbock—City, W. H. Rodgers, mgr., plans electric light and power plant, incl. gas engine, power plant unit, power house dynamos, power and light distributing lines, etc. $100,000. P.W.A. project. Expect to get authority and advertise for bids at once. Engineer, c/o owners, engr.

Tex., Port Lavaca — City, F. M. Dudgeon, mayor, bids about Dec. 1, 2 story, 120x180 ft., concrete mill type power plant, two 125 hp. gas engines two 95.5 kva. generator, 20 ton ice plant, all new machinery and equipment, one 100 hp. boiler, incl. refrigeration, cold storage, oyster and shrimp storage facilities; and harbor and beach improvements, incl. 60,000 yd. dredging, canning factory, complete equipment, 250 ft. heavy timber wharf, fertilizer factory. $190,000. P.W.A. loan and grant for $140,600. Garrett Eng. Co., 300 Hughes St., Houston, and Port Lavaca, engrs.

Tex., Weslaco — City, J. C. Compere, Jr., mayor, plans municipal electric light and power plant, motor driven turbines, distributing underground lines, etc. $210,000. Application filed with P.W.A. Bd. for funds. J. E. Ward, Harvey-Snider Bldg., Wichita Falls, engr.

W. Va., Logan—American Gas & Electric Co, 30 Church St., New York, N. Y., sketches steam-electric power plant, 100,000 kw. capacity.

Alta., Edmonton—Northern Canada Development Holdings Ltd., plans constructing 2,000 hp. power development on Old Man River, north of Lake Athabaska.

B. C., Vancouver—G. P. Meehan, Vancouver, sponsoring 50,000 hp. power plant on Cheakamus River. Plans ready in November.

Ontario—Provincial Govt. and Ontario Hydro-Electric Comn., Toronto, plans power development, canal, dam, etc., to divert water of Ogaki River into Nipigon River and Great Lakes. $3,000,000.

Que., Montreal—C. Des Baillets, ch. engr. Waterworks Comn., submits plan to City Executive Com. for development of hydro-electrical plant, 20,000 hp. capacity to supply city's needs.

Sask., Estevan—Dominion Electric Power Co. Ltd., W. H. Schlosser, mgr., plans addition to plant, inclusive of installation of 1,500 kw. capacity unit. $55,000. Loch & Shaw, Inc., 57 William St. New York, N. Y., engrs.

Sask., Regina — Municipality, E. W. Bull, mgr., soon takes bids constructing high pressure, high temperature steam generation unit, steam turbine generator unit, with foundations, pipes and all connections. $600,000.